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161	The Palms of Southeast Madagascar: Fort Dauphin as a <i>Revenea</i> Hotspot
	L. AUREGLIA, M. RAKOTOARINIVO & B. VILA

177	<i>Sabal miamiensis</i>: Discovery of a New Wild Population and Restoration Efforts
	D.A.TUCKER, M.J. SANÍN, M.P. GRIFFITH, S. VALENZUELA, L. NUÑEZ & A.A. KHODDAMZADEH

183	The Palm Flora of the Meratus Mountains in Kalimantan, Indonesia as Observed in the 1970s
	J. DRANSFIELD

Features

Palm News	160
Index to vol. 69	202
Statement of Ownership	205
Patrons of the IPS	208



FRONT COVER

Ravenea cycadifolia. See article by L. Aureglia et al., p .161.
Photo by B. Vila.

BACK COVER

Wild *Sabal miamiensis* in a mosaic of *Serenoa repens*. See article by D.A. Tucker et al., p. 177. Photo by Selvyn Valenzuela and D.A. Tucker.



Calamus scipionum with its immensely long inflorescences and climbing whips (flagella) climbing into the forest canopy. See article by J. Dransfield, p. 183. Photo by J. Dransfield.

PALM NEWS

A team of plant pathologists led by Dr. Braham Dhillon at the University of Florida Institute of Food and Agricultural Sciences' Fort Lauderdale Research and Education Center developed **a new way of testing palms for susceptibility to heart and trunk rots** caused by the fungus *Thielaviopsis ethacetica*. The new assay uses detached leaflet sections wounded and inoculated with the fungus, then monitored for lesion development. The tested 29 palm species in 17 genera and found that the most susceptible palms are: *Pseudophoenix sargentii*, *P. vinifera*, *Wodyetia bifurcata*, *Roystonea borinquena* and certain cultivars of *Cocos nucifera*. The work is online ahead of publication in Plant Disease at <https://doi.org/10.1094/PDIS-07-25-1577-RE>



Scott Zona

An account of the four species of *Korthalsia* in Thailand has been published by C. Ngernsaengsaruy and colleagues in the online journal PeerJ (An account of *Korthalsia* (Arecaceae) rattans and their uses in Thailand. PeerJ 13:e19935 <https://doi.org/10.7717/peerj.19935>). The open-access article examines morphology, distribution, ecology and use. The authors give preliminary conservation assessments, and fortunately, none of the four species is threatened. The species are assessed as Least Concern.

Bye-bye, *Wallichia*. Marc Jeanson, Thomas Couvreur and Andrew Henderson have produced a comprehensive revision of the tribe Caryoteae and synonymized *Wallichia* with *Arenga*. Morphological and molecular data back up the taxonomic decision to combine these two genera. The authors published six new combinations in *Arenga* and one new combination in *Caryota*. One species of *Arenga* was moved to *Caryota* (*C. hastata*), which means that the genus *Caryota* now includes both bipinnate- and pinnate-leaved species. The new work [A revision of tribe Caryoteae (Arecaceae, Coryphoideae). Phytotaxa 719: 1–141] includes full descriptions, distribution maps, photographs, habitat information and notes on reproductive biology and etymology.



Scott Zona

The Palms of South-east Madagascar: Fort Dauphin as a *Ravenea* Hotspot

LOUIS AUREGLIA¹, MIJORO RAKOTOARINIVO² AND BRUNO VILA¹

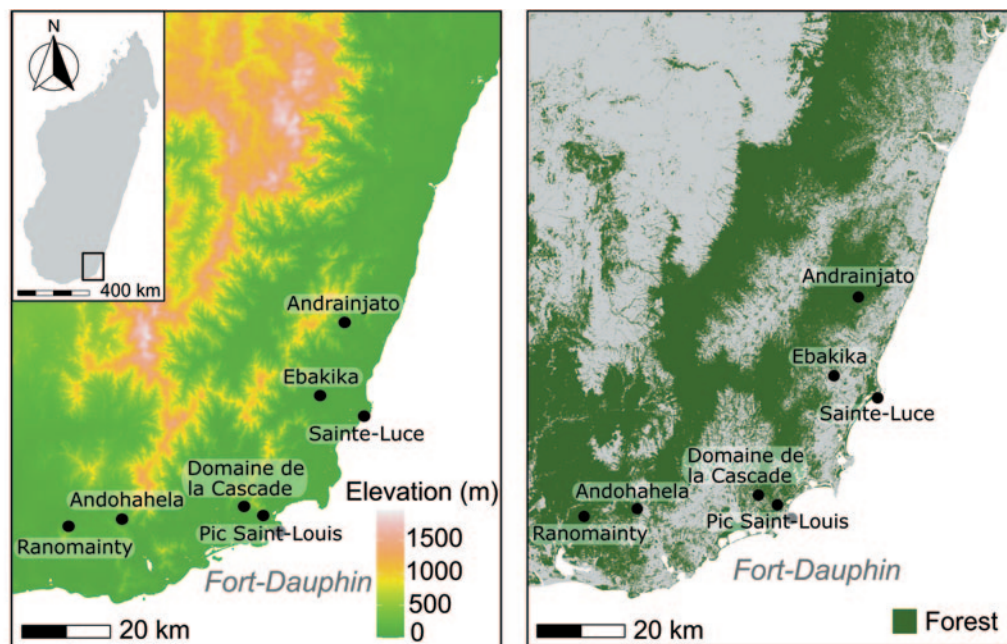
Southeast Madagascar, especially the Fort Dauphin (Taolagnaro) district, represents one of the last remnants of the original rainforest along the island's eastern coast and marks the transition between humid and arid climatic zones. Here, we report findings from an expedition in March and April 2024, which demonstrate that the southern part of Fort Dauphin seems to be a significant “hotspot” for the genus *Ravenea*. Its location in the southern half of the region, previous biogeographic events and distinct, stable climate patterns may all contribute to this particular richness. Surprisingly, the taxonomy of palm species in this area is still not well understood, even though it is reasonably accessible.

Madagascar is well-known as one of the hottest biodiversity conservation hotspots due to its high species richness, significant levels of endemism and considerable anthropogenic pressure on ecosystems (Myers et al. 2000, Ganzhorn et al. 2001), featuring a unique flora with important palm species. The island is home to 208 native palm species, 98% of which are endemic, making its palm flora one of the most distinctive in the world (Dransfield

& Beentje 1995, Rakotoarinivo et al. 2020, POWO 2025). Most of this diversity is found in the eastern rainforests, which historically formed a continuous band of vegetation along the island's eastern escarpment and lowlands (Green & Sussman 1990). However, these primary forests have been significantly degraded due to widespread deforestation. Forest loss is mainly driven by various human activities such as agriculture, logging and the practice of *tavy* (slash-and-burn agriculture), which explains why 83% of palm species in the region are threatened with extinction (Rakotoarinivo et al. 2014). Consequently, continuous forests have been reduced to fragmented remnants, resulting in isolated patches of vegetation that are exposed to ongoing threats. Fragmentation severely limits our understanding of Madagascar's original palm diversity. Well-preserved primary forests are now rare and confined mainly to remote,

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1. Map of the study area in the southeast corner of Madagascar. Left: Digital Elevation Model (DEM) of the study area, with elevation ranging from low (green) to high (pink), based on data from AWS Terrain Tiles. Right: land cover map from the Copernicus Global Land Cover dataset by Terrascope, illustrating forest cover in green. All study sites are marked on both maps.

inaccessible areas. Some palms could well be extinct and many others have been recorded only within minute forest fragments (Rakotoarinivo et al. 2020). This underlines the necessity of preserving Madagascar's exceptional palm flora (Britt et al. 2004).

One location of special interest is the Fort Dauphin area in southeast Madagascar, which forms an important ecological transition between the humid eastern rainforests and the arid southern spiny forests (Bollen & Donati 2006). This transition harbors a diverse range of vegetation, from the forests on sands of Petriky and the swamp forests of Sainte Luce to the humid montane forests of Andohahela, which extend from lowland to high-elevation zones. Nearby to the southwest, there is a transition toward dry bushland and spiny thickets dominated by Euphorbiaceae and Didiereaceae. Regional rainfall varies from 1,300 to over 3,200 mm annually, reflecting a pronounced east-west gradient driven by the orographic influence of the Anosy mountains. This climatic variation gives rise to a complex mosaic of vegetation, ranging from perhumid to subarid zones, which supports high levels of endemism and renders the region particularly valuable for biodiversity research and conservation efforts (Moat & Smith 2007).

The current vegetation has been in existence for more than 50,000 years, enduring severe climatic fluctuations during the last Quaternary period, which contributed to its distinct composition (Virah-Sawmy et al. 2009). Despite its richness in ecosystems, this location remains under-explored for its palm species.

Fort Dauphin and its surrounding areas include various types of forests, such as the Tsitongambarika forest, the Sainte Luce littoral forests and the southernmost parts of the Anosy mountain range. Tsitongambarika features significant areas of primary forest cover and is moderately accessible. However, the botanical exploration of the region, especially its palm flora, has only recently gained more attention (Dransfield & Rakotoarinivo 2012). This suggests that, despite the limited surveys conducted to date, the biodiversity of these areas is probably richer than we previously believed.

The genus *Ravenea* is of particular interest, as it represents one of Madagascar's most distinctive palm groups (Dransfield & Beentje 1995), being the most species-rich genus of Malagasy palms outside subtribe *Dypsidinae* (Eiserhardt et al. 2024) and displays remarkable ecological specialization and diversity. We



2 (top). View of Tsitongambarika forest, with a waterfall cascading through dense vegetation. 3 (bottom). *Ravenea sambiranensis*. Photos: L. Aureglia.

conducted a botanical mission throughout southeast Madagascar from 25 March to 6 April

2024, investigating palm diversity in the Fort Dauphin region and concentrating on *Ravenea*



4 (top). *Ravenea dransfieldii*. 5 (bottom). *Dypsis elegans*. Photos: L. Aureglia.



6. *Chrysalidocarpus mananjarensis*. Photo: L. Aureglia.

diversity in particular to address knowledge gaps in the genus. Key survey sites included Tsitongambarika, Sainte Luce, Pic Saint Louis, Domaine de la Cascade, Ivorona and Andohahela National Park (Fig. 1). Here, we provide a first report on the diversity, geographic distribution and ecology of *Ravenea* in different habitats in these locations, presenting new data for its taxonomy and for its conservation. We also document other palm species encountered during field surveys and assess the significance of southeast Madagascar for the distribution and conservation of *Ravenea*.

Tsitongambarika: rich biodiversity in a lowland rainforest

We conducted a field survey in regions where some *Ravenea* species of interest have been documented in the past (Dransfield & Rakotoarinivo 2012). Our journey began in Fort Dauphin on 25 March, when we prepared for fieldwork before traveling to Tsitongambarika, one of the largest remaining lowland rainforests in Madagascar. The journey involved gathering necessary supplies, securing research permits and coordinating logistics for

fieldwork, including travel by car and in dugout canoes.

On 26 March, we departed Fort Dauphin early in the morning, traveling northeast toward Tsitongambarika by car. The road trip required multiple river crossings using locally made floating rafts to transport vehicles across streams. This gave us the opportunity to observe the widespread presence of *Elaeis guineensis* and *Raphia farinifera*. Upon reaching Ampasy, we transferred to a dugout canoe to navigate the river toward Andrainjato, an important location for biodiversity research.

Upon arrival, our exploration started in Tsitongambarika (Fig. 2) where we encountered numerous palm species over the following days, including *Ravenea sambiranensis* (Fig. 3), *R. lakatra*, *R. dransfieldii* (Fig. 4), *R. hypoleuca*, *R. robustior*, *Dypsis elegans* (Fig. 5), *D. brevicaulis*, *D. pinnatifrons*, *Chrysalidocarpus mananjarensis* (Fig. 6), *C. prestonianus*, *C. saintelucei*, *Vonitra utilis*, *Orania trispatha* (Fig. 7) and *Elaeis guineensis*. Our time in Tsitongambarika involved numerous challenges, including long treks through wet, muddy terrain and frequent river crossings. Despite these difficulties, the



7 (left). *Orania trispatha*. Photo: L. Aureglia. 8 (right). Fruits of *Ravenea cycadifolia*. Photo: B. Vila.

variety of palms encountered made this an incredibly rewarding site.

Among these palms, the presence of *Ravenea lakatra* and *R. dransfieldii* is interesting because it extends their known distribution. Previously documented between Andasibe and Vangaindrano in central-eastern Madagascar, with additional records in Masoala to the north, *R. lakatra* is typically found in moist lowland forests on mid-slopes or ridge crests at elevations of 90–850 m (Jumelle 1927, Dransfield & Beentje 1995). Given its Critically Endangered status, further research is essential to clarify its demographic trends, assess habitat stability, and determine whether its distribution is broader than currently recognised. Similarly, *R. dransfieldii* was only documented previously between Marojejy and Ifanadiana in eastern Madagascar (Beentje 1994). In addition, this occurrence is the southeasternmost, representing a significant extension beyond its known range.

Our expedition's key achievement was discovering on March 27 a wild population of *Ravenea cycadifolia* (Figs. 8 & 9) in Tsitongambarika, the first documented record in its natural habitat. After extensive exploration, we located a wild population consisting of approximately one hundred individuals. Previously the species has long been known in cultivation, notably at Floribunda Palms

and Exotics in Hawaii, from where the type specimen (*Baker 1457* at Kew) was collected, and in several other collections (Dransfield 2020). A mature fruiting specimen also grew in the garden of Olivier Reilhes in La Réunion, from which key diagnostic features were described, including unusually large fruits with sublateral stigmatic remains (Fig. 8). Its introduction into horticulture likely stems from seeds originally collected near Mahatalaky in southeast Madagascar and distributed internationally. The first known photograph of a wild individual was taken near Mahatalaky by a local collector working for Günther Gottlieb and later published by Dransfield (2020) through Toby Spanner, representing the earliest sight record of *R. cycadifolia* in its natural habitat.

In cultivation, the species has been noted for its distinctly cycad-like appearance, with its stout trunks and rigid, dark green pinnate leaves. In the wild, *R. cycadifolia* grows in dense forests with a closed canopy, often on steep, rocky slopes and riparian plateaus where water seeps through (Fig. 9). Its adventitious roots help it anchor to these slopes.

Sainte Luce: littoral forest exploration

On 28 March, we relocated from Tsitongambarika to Sainte Luce. The journey involved a combination of hiking, canoeing and a drive to Ebakika (Fig. 10) before continuing



9. *Ravenea cycadifolia*. Photo: B. Vila.

southwards by dugout canoe. With its proximity to the coast and the influence of sandy soils, this region supports palm assemblages distinct from those found further inland. Sainte Luce features littoral forests dominated by *Cocos nucifera*. Then, further to the west, we located several individuals of

Ravenea musicalis and *Dypsis commersoniana*. *Ravenea musicalis* is a spectacular species that grows in the beds of rivers (Beentje 1993). We observed it at two localities. First, we recorded the well-known population near the bridge on the road to Mahatalaky. Then, we searched for the population reported along the Ebakika



10 (top). View of the Ebakika River, featuring numerous, spectacular *Ravenea musicalis* palms growing directly in the water. 11 (bottom). *Ravenea musicalis*. Photos: L. Aureglia.

River prospecting the three previously documented subpopulations (Hogg & Henshall 2014). However, no individuals were observed

at two of these previously reported subpopulations and local residents indicated that the species is no longer present in those areas

due to harvesting of the palm heart for consumption. The fieldwork confirms the decline of the population of *R. musicalis* along the Ebakika River, one of the three rivers where the species is known to occur. The only remaining subpopulation was found at the river intersection (Fig. 11), reinforcing concerns about the ongoing decline of the species and emphasizing the urgent need for conservation action.

Pic Saint Louis: a mountain of diversity

On March 30, we set out to explore Pic Saint Louis, a well-known yet somewhat off-the-beaten-path mountain near Fort Dauphin that still holds significant biodiversity value. At its summit, we documented two well-known palms: *Dyopsis nodifera* (Fig. 12) and *Beccariophoenix madagascariensis* (Fig. 13). We also collected specimens of a recently described species, *Ravenea conferta* (Fig. 14) which is known only from the summit of Pic Saint Louis. The slopes of the mountain have been almost entirely deforested due to repeated *tavy* and uncontrolled bushfires (Bollen & Donati, 2006), resulting in a much more exposed environment than the shaded forest sites

surveyed earlier. *R. conferta* persists in a small relict patch of vegetation at the summit, sheltered behind a rock formation that has likely protected it from recurring fires. This location currently harbours the only known population of the species globally, consisting of no more than 15 individuals.

Domaine de la Cascade: a hidden rainforest

On March 31, we arrived at Domaine de la Cascade, a privately managed forest where Olivier Reilhes suggested the presence of notable palm diversity (Reilhes 2020). Shortly after beginning our survey, we came across *Ravenea julietiae* (Fig. 15) growing near the river. This species was primarily recorded between Mananara Avaratra and Vangaindrano (Beentje 1994) and has now been found even further south, suggesting a broader ecological tolerance than previously recognized. Then, heavy rainfall soon forced us to abandon our exploration. Swollen rivers made it impossible to safely cross to areas where *Ravenea krociana*, a giant palm, was thought to be present, highlighting the unpredictable nature of fieldwork in these environments.

12. *Dyopsis nodifera*. Photo: L. Aureglia.





13. *Beccariophoenix madagascariensis*. Photo: L. Aureglia.

Ivorona and Andohahela National Park: transitional vegetation

On April 2, we began our journey to Ivorona and Andohahela National Park, focusing on transitional forest areas where humid

vegetation merges with dry spiny forest elements. Among the species observed were *Elaeis guineensis* and *Chrysalidocarpus decaryi* (Fig. 16), commonly known as the triangle palm, which was particularly abundant along the road to Ranopiso. We also spotted *Ravenea*



14. *Ravenea conferta*. Photo: L. Aureglia.

xerophila in the distance on a mountain slope, although we were unable to reach it before nightfall despite an extended walk. The ecological variation across the area, from riverine environments to dry upland slopes, contributed to the richness of the palm assemblage encountered.

Southeast Madagascar: A Hotspot for *Ravenea* Diversity and Conservation Challenges

We recorded 26 species of palms in the region of Fort Dauphin, particularly in the Anosy mountain area, which represents more than 10% of the palm species in Madagascar. Among these, 10 belong to the genus *Ravenea*, out of the 25 species currently known in the genus. Notably, only 4 are not considered threatened, according to the latest conservation status of the IUCN Red List. While this high proportion of threatened species reflects the general pattern observed across Madagascar, our survey nonetheless underscores major conservation concerns for several *Ravenea* species, particularly those classified as Critically Endangered (CR), including *Ravenea hypoleuca*, *R. lakatra* and *R. musicalis*.

In addition, we observed the presence in this region of several rare and very localized species, such as *R. cycadifolia*, *R. conferta* and *R. musicalis*. This region is also known as the habitat of *R. declivium* (Dransfield & Rakotoarinivo 2012), although it was not observed during our field survey. Among them, *R. conferta*, *R. declivium* and *R. cycadifolia* are currently known from a single locality. Although it is possible that additional populations exist, their limited known distribution makes them particularly vulnerable to habitat degradation and loss. Our fieldwork also documented the decline of the *R. musicalis* subpopulation along the Ebakika River, one of the three rivers where the species is known to occur. This reinforces concerns about its ongoing decline and emphasizes the urgent need for conservation action. Finally, we also underscore the presence of other species of *Ravenea* not known in this region, such as *R. dransfieldii* and *R. lakatra*. In addition, we encountered a morphologically distinctive *Ravenea* population in the Anosy chain, suggesting that the regional diversity of the genus may still be underestimated.

These newly documented range extensions refine our understanding of *Ravenea*



15 (top). *Ravenea julietiae*. 16 (bottom). *Chrysalidocarpus decaryi*. Photos: L. Aureglia.

distribution, suggesting that southeast Madagascar includes areas that had not previously been recognised as suitable for these

species. As already suggested by Dransfield (2020), our findings further support the idea that southeast Madagascar is a hotspot and

key center of diversity for *Ravenea*. Understanding the origins of this diversity requires a closer examination of the region's unique biogeographic context.

Southeast Madagascar likely represents a center of *Ravenea* diversity that has been shaped by the convergence of climatic, geological and historical factors. The region spans a marked climatic gradient, from perhumid conditions along the eastern escarpment to subhumid and semi-arid zones further west (Moat & Smith 2007). This gradient arises from orographic effects, as the escarpment captures Indian Ocean trade wind moisture, resulting in high rainfall on windward slopes and aridity on the leeward side (Liu et al. 2024). These contrasts create a diversity of habitats that support a broad range of *Ravenea* species, from wetland-adapted forms like *R. musicalis* to montane species such as *R. lakatra* and xerophytic types like *R. xerophila*.

The long-term geomorphological evolution of the Great Escarpment has further driven diversification. Its gradual retreat produced a fragmented topography of valleys and peaks, limiting gene flow and promoting allopatric speciation (Wang et al. 2021). The restricted ranges of species like *R. conferta* (Pic Saint Louis), *R. cycadifolia* and *R. declivium* (Tsitongambarika) reflect the role of topographic isolation in this process (Rakotoarinivo 2024).

During the Quaternary, climatic oscillations repeatedly altered forest extent, reinforcing population isolation while preserving microrefugia that enabled lineage persistence and adaptation (Vences et al. 2009, Antonelli et al. 2022). These conditions of climatic heterogeneity, geological fragmentation and long-term environmental stability have favored ecological specialization, reduced competition and promoted coexistence among *Ravenea* species (Rakotoarinivo et al. 2013, Eiserhardt et al. 2024). Unlike other regions of Madagascar where deforestation has been severe, the southeast has retained relatively intact forests, providing continuity for palm diversification even through broader climatic fluctuations (Antonelli et al. 2022). We therefore propose that this region has functioned as both a refuge and a dynamic evolutionary arena for *Ravenea*, fostering repeated speciation and establishing it as a key hotspot for palm and overall biodiversity.

To conclude, our field survey suggests that there may be other species to be discovered in

these underexplored areas, such as Tsitongambarika and Andohahela. Indeed, the presence of *R. conferta* on the summit of Pic Saint Louis raises intriguing questions about the potential diversity of *Ravenea* on other peaks within this range. Future studies should aim to map the distribution of *Ravenea* species more broadly and assess their population state to inform targeted conservation strategies and conserve this emblematic element of Madagascar's flora.

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Table 1. Inventory of palms recorded in the south-east of Madagascar, Fort Dauphin district, Anosy region. The occurrence in a locality is indicated by a collector number where herbarium specimens were collected or with a symbol (+) where a sight record was made or (-) for an unsure occurrence. Abbreviations correspond to collectors: LA (Louis Aureglia). Specimens are deposited at the herbaria at MARS and TAN.									
Species	Southwest Fort Dauphin			South-Central Fort Dauphin			Southeast Fort Dauphin		
	Ranomainty	Andohahela		Pic Saint Louis	Domaine de la Cascade		Sainte Luce	Ebakika	Andrainjato
1. <i>Beccariophoenix madagascariensis</i>				+					
2. <i>Chrysalidocarpus decaryi</i>	+	+							
3. <i>Chrysalidocarpus mananjarensis</i>								+	
4. <i>Chrysalidocarpus prestonianus</i>				+				+	
5. <i>Chrysalidocarpus saintelucei</i>								LA166	
6. <i>Cocos nucifera</i>						+			
7. <i>Dypsis brevicaulis</i>								LA160	
8. <i>Dypsis commersoniana</i>								LA174	
9. <i>Dypsis elegans</i>								LA161	
10. <i>Dypsis henrici</i>								LA171	
11. <i>Dypsis nodifera</i>				+					
12. <i>Dypsis pinnatifrons</i>								+	
13. <i>Elaeis guineensis</i>	+			+					
14. <i>Orania trispatha</i>								+	
15. <i>Raphia farinifera</i>				+					

Table 1 (continued)

Species	Southwest Fort Dauphin		South-Central Fort Dauphin		Southeast Fort Dauphin		
	Ranomainty	Andohahela	Pic Saint Louis	Domaine de la Cascade	Sainte Luce	Ebakika	Andrainjato
16. <i>Ravenea conferta</i>			LA177, LA178, LA179				
17. <i>Ravenea cycadifolia</i>							LA167, LA168, LA169
18. <i>Ravenea dransfieldii</i>							LA164
19. <i>Ravenea hypoleuca</i>							LA170
20. <i>Ravenea julietiae</i>				LA180, LA181			
21. <i>Ravenea lakatra</i>							LA163
22. <i>Ravenea musicalis</i>					LA175, LA176	LA172, LA173	
23. <i>Ravenea robustior</i>							+
24. <i>Ravenea sambiranensis</i>							LA165
25. <i>Ravenea xerophila</i>		~					
26. <i>Vonittra utilis</i>							+

Sabal miamiensis: Discovery of a New Wild Population and Restoration Efforts

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KHODDAMZADEH²

Continued field investigations have revealed a second wild population of *Sabal miamiensis* within its historic range, and collaborative conservation actions are now underway to support the species' recovery in South Florida.

Following our initial report confirming that *Sabal miamiensis* (Miami palmetto) persists in the wild (Tucker et al. 2024), we have documented a new population of this palm within 5 miles (8 km) from the original site. This second population comprises roughly forty individuals in a protected pine forest fragment. All size classes from seedlings to mature, reproductive palms are present. Notably, many adults in this newly discovered cohort appear to be healthy (Fig. 1) and were observed flowering and fruiting. The habitat closely mirrors that of the first site—an oolite-moderated sandy pineland-scrubby hammock—and lies within the species' historical range as described by Zona (1985). The discovery of this additional wild stronghold so nearby

underscores that *S. miamiensis* was surviving in obscurity in multiple refugia despite decades of assumed extinction.

The original population in Miami-Dade County also continues to be monitored and managed (Fig. 2). We now estimate that the site harbors on the order of 30–60 individuals, after more extensive surveys revealed additional juveniles. Some fluctuation in this count reflects minor losses: a few plants were inadvertently lost during recent habitat restoration efforts at the site (Fig. 3). Invasive woody species removal and prescribed fire (conducted to improve pine rockland habitat quality) caused *S. miamiensis* recruitment mortality and damaged mature specimens. Nevertheless, the overall population appears stable, and regeneration through seedling recruitment was noted. Both known populations occur on county-managed conservation land where active restoration is expected to yield long-term habitat improvements. We are refining management recommendations to minimize further

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1. *Sabal miamiensis* leaf displaying the classic characters of having deeply divided leaflets, strongly costapalmate form, present fibers, interlocking leaflets, and a strong downward curve.

accidental impacts on this critically imperiled palm while enhancing its native ecosystem.

In tandem with these wild discoveries, a proactive reintroduction effort has been initiated as part of a comprehensive conservation strategy. In March 2025, our team reintroduced two nursery-grown *Sabal miamiensis* individuals into the new population site (Fig. 4). These palms, grown at Montgomery Botanical Center (MBC) using seeds from Montgomery's living collections, were planted in a carefully prepared microsite within a recently restored area of the preserve. The outplanting is the first deliberate augmentation of a wild *S. miamiensis* population. Both transplanted individuals were of substantial size (7-gallon container specimens) to maximize establishment success. This effort was a collaborative undertaking by MBC, the Miami-Dade County Environmentally Endangered Lands (EEL) Program, Florida International University (FIU) and Botanic Gardens Conservation International (BGCI). Prior to planting, the EEL Program restoration crew removed invasive plants and reintroduced native understory associates at the site, recreating the conditions of the historical pine rockland community (Fig. 5). The introduced palms have been permanently tagged and will be monitored closely as part

of a long-term study of adaptation, growth, and ecological interactions *in situ*. Their performance will inform future reintroduction attempts, including larger-scale plantings planned as additional nursery stock reaches an appropriate size.

These recent actions are part of a broader conservation initiative centered on *S. miamiensis*. A strong partnership between local and international institutions has been key to the progress achieved. MBC has taken the lead on *ex situ* propagation, leveraging its living collections and seed bank to preserve genetic stock. With support from a BGCI Global Botanic Garden Fund grant, MBC produced over one hundred seedlings from pollination of *ex situ* plants, ensuring a supply for reintroduction (Fig. 6). Miami-Dade County's EEL Program, which manages the preserves harboring the palm, has facilitated field surveys and habitat management, providing secure sites for both the wild palms and the new plantings. Academic collaboration through FIU has provided research guidance—*S. miamiensis* is serving as a focal case study in conservation horticulture and restoration ecology and the PhD focus of Daniel A. Tucker. This multi-institution collaboration exemplifies an interdisciplinary approach: combining field botany, horticulture, ecology,



2. *Sabal miamiensis* L16 from the original site. The largest specimen found to date.

and community engagement. Such a framework has elevated *S. miamiensis* from a botanical curiosity to a model for plant conservation, highlighting how coordinated efforts can yield tangible gains for a species once thought lost. In addition, laboratory efforts to develop in vitro micropropagation for *S. miamiensis* are underway to increase plant numbers and provide a backup to conventional seed propagation, including acclimatization and synthetic seed production.

From an ecological standpoint, the re-inforcement of *S. miamiensis* in its native pine rockland ecosystem carries significance beyond saving a single species. This palm is part of the natural heritage of the Miami Rock Ridge's flora, and its presence contributes to the biological diversity and structural complexity of the habitat. Restoring *S. miamiensis* may also revive ecological interactions; for instance, its large fruits likely provided seasonal food for wildlife, and its fronds and trunks contribute to the physical environment used by native fauna (Fig. 5). The two known sites are in relatively close proximity, which raises the possibility of gene flow if pollinators (such as bees or palm-specialist insects) and seed dispersers move between populations. We are investigating the genomic diversity within and between these populations to inform

management. All seedlings propagated for reintroduction are being sourced from multiple parent plants to help ensure variation across all known wild populations, an effort that will be better informed through genotyping of breeding stock. In addition, laboratory efforts to develop in vitro micropropagation for *S. miamiensis* are underway to further increase plant numbers and serve as a backup to traditional seed propagation. By safeguarding a broad genetic base, we aim to enhance the species' adaptability and resilience, which will be critical for its long-term survival amid environmental changes.

In less than two years, *Sabal miamiensis* has gone from obscurity and presumed extinction to a focal point of conservation action. The species is now formally recognized as part of South Florida's flora, having been added to regional plant inventories and conservation lists as a native taxon. For example, it is currently ranked as Critically Imperiled in the Floristic Inventory of South Florida, reflecting its extremely limited distribution and population size by the Institute for Regional Conservation. While the wild populations remain small, the outlook for the Miami palmetto is markedly improved. Through continued monitoring, habitat management, and strategic augmentations, we anticipate



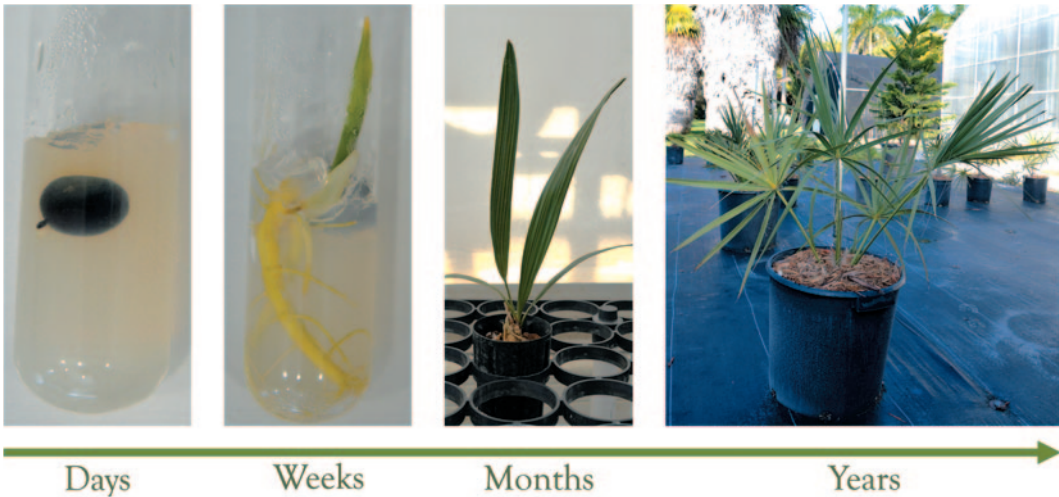
3 (top). *Sabal miamiensis* juvenile recovering from an accidental removal of the entire above ground portion during restoration work from the original population. 4 (bottom). Students from Miami Norland Senior High School and Miami-Dade County EEL Staff assisting with a reintroduction. Reintroduced *Sabal miamiensis* is pictured center.

that *S. miamiensis* will strengthen its foothold in the wild. This ongoing project illustrates how targeted research and conservation partnerships can effectively pull a palm species back from the brink. In the case of *S.*

miamiensis, what began as a serendipitous discovery of “not extinct” has evolved into a coordinated effort to secure the species’ future. We conclude on an optimistic note: the Miami palmetto, once a ghost of Florida’s past, is on



5. D. A. Tucker amongst the *Sabal* and *Serenoa*. Multiple *S. miamiensis* are visible. While not a pine rockland *sensu stricto*, the soil consists of sandy marine deposits over oolitic limestone, thus differentiating from the deep acid sands of Central Florida. The vegetation community is that of the Subtropical Scrub of Miami Ridge/Atlantic Coastal Strip.



6. *Sabal miamiensis* from seed to plant in MBC’s nursery. Note, this seed was germinated in agar to show development; *S. miamiensis* seeds will germinate readily in most soils like other *Sabal* species.

the path to recovery and is now duly acknowledged in the botanical landscape of South Florida.

Acknowledgments

We thank the Miami-Dade County EEL Program staff (especially Joy Klein and Kirk Linaje) for site access, field assistance, and habitat restoration work. We are grateful to Montgomery Botanical Center staff and volunteers for propagation and planting support. We would like to thank specifically Isabella Childress for her contributions to our understanding of *S. miamiensis* pollination techniques and Vickie Murphy for her excellent propagation and care of *S. miamiensis* in the nursery. This project was supported in part by grants from BGCI’s Global Botanic Garden Fund, the Florida Native Plant Society,

the International Palm Society, and the Kelly Foundation, which made the recent reintroduction possible. Additional thanks to Florida International University for research support and to Trimble Geospatial for the donation of the DA2 and TDC6 survey equipment used in this study. Finally, we extend our sincere thanks to Dr. Scott Zona for his continued guidance and support, as well as to Dr. William Baker and the editors and reviewers for their constructive input, which improved this manuscript.

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The Palm Flora of the Meratus Mountains in Kalimantan, Indonesia as Observed in the 1970s

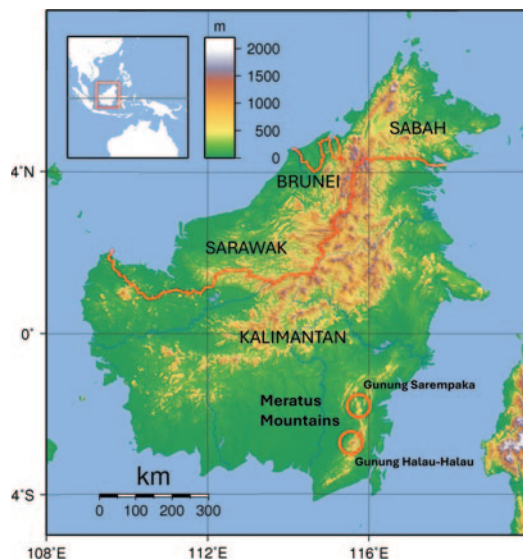
JOHN DRANSFIELD¹

The isolated Meratus range of mountains runs north-south along the border between the provinces of South and East Kalimantan, the Indonesian part of the island of Borneo (Fig. 1). When compared with the central Bornean highlands and the massive mountains of Sabah that culminate in Gunung Kinabalu (4095 m above sea level), Meratus boasts a high point, Gunung Besar (Gunung Halauhalau), of a mere 1901 m.

During my four years (1970–1974) attached to Herbarium Bogoriense in Bogor, Java, as part of a British Government aid project, I made two expeditions to the Meratus Mountains, concentrating on surveying and collecting palms, in particular rattans. The first trip focused on the north of the range in the foothills of Gunung Sarempaka in November 1971 and the second on the central part of the range in October 1972, during which an ascent of Gunung Besar (Gunung Halauhalau) was made. During these two expeditions, we made many herbarium collections of palms, documenting what at the time was a very poorly known palm flora. A full set of these collections is housed in Herbarium Bogoriense in Bogor, with duplicates distributed to Leiden

Herbarium, Kew Herbarium, the L.H. Bailey Hortorium and several other herbaria, when sufficient material allowed. Ripe palm seeds, where available, were collected for the living collection of the Kebun Raya, Bogor (Bogor Botanical Gardens) and also for the Palm Society's Seed Bank. The two trips, early in my career as a palm botanist, were very exciting, introducing me to a diversity of Bornean palms, rather different from those of northern Sarawak and Brunei where I had worked during my PhD fieldwork in 1968. We made new records of palms previously known only from Kinabalu and the higher mountains of Sarawak, collected species new to science and, perhaps most thrillingly, found material of a massive rattan that I eventually described as a new genus, *Retispatha*, which, while now sunk into *Calamus*, occupies a very isolated evolutionary position among other rattans. However, more of this later. I have been

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1. Map of Borneo showing Meratus mountains.

prompted to write this account after browsing through my old field diaries and collecting books, and realizing just how little about the Meratus palm flora has been documented in print.

In those now far-off days, we used old-fashioned 35 mm film cameras. Color film was expensive and so used sparingly and at the time had to be sent to Australia for processing, so very different from these days of digital photography and instant results. Thus, my photographic record of the two expeditions is limited.

Jaro Dam, Muara Uya and the foothills of Gunung Sarempaka

In June 1971, I had conducted fieldwork in Kutei in East Kalimantan and to reach there had flown from Jakarta to Balikpapan; as we flew over southern Borneo, we crossed a range of mountains, with dramatic outcrops of karst limestone and, at that time, excellent forest cover. I identified this area on maps as the Meratus Mountains, and I decided then and there that I would plan a future expedition there.

This plan was encouraged by Dr. Anwari Dilmy, previous Keeper of the Herbarium in Bogor, who took up the post of Rector of Universitas Lambung Mangkurat in Banjarmasin, Kalimantan Selatan in 1971. He invited us to visit, provided hospitality in the regional capital, and perhaps most importantly, helped us to decide where in the Meratus to go and how to get there. Our group consisted of Dr.

The Palm Flora of the Meratus Mountains in the early 1970s.

Herbarium specimens made by the author are indicated by initials (JD) and a unique collection number.

Areca catechu
Areca kinabaluensis JD2835
Arenga brevipes JD2137, JD2155, JD2157, JD2158, JD2159, JD2160, JD2161
Arenga pinnata
Arenga undulatifolia JD2235, JD2297, JD2298, JD2299
Calamus ater JD2309, JD2809, JD2826, JD2827
Calamus caesius JD2290
Calamus calciphilus JD2245, JD2251, JD2320, JD2336
Calamus crinitus subsp. *crinitus* JD2176
Calamus crinitus subsp. *sabut* JD2802, JD2806, JD2981
Calamus disjunctus JD2074, JD2115, JD2814, JD2819
Calamus dumetosus JD2333, JD2830, JD2840
Calamus erioacanthus JD2800. JD2980
Calamus geniculatus JD2098
Calamus gracilipes JD2116, JD2808
Calamus hallierianus
Calamus hirsutus subsp. *korthalsii* JD2078, JD2079, JD2103, JD2135, JD2789, JD2796, JD2804
Calamus sp. aff. *C. heteroideus* JD2848, JD2858, JD2859, JD2920
Calamus javensis JD2101, JD2109, JD2131, JD2175, JD2791, JD2860
Calamus longipes JD2293
Calamus manan JD2231, JD2825
Calamus marginatus JD2130, JD2136, JD2982
Calamus melanochaetes JD2133, JD2799
Calamus oblongus subsp. *elongatus* JD2064, JD2810, JD2811
Calamus ornatus JD2798
Calamus paspalanthus JD2104, JD2154, JD2173, JD2816, JD2817

continued opposite

E. Kuswata Kartawinata, forest ecologist, at the time recently returned to Bogor from his doctoral studies in Hawaii, Drs Ed de Vogel, from Leiden in the Netherlands, based in Bogor for a project on the seedlings of forest trees and Otjid and Didin Saeruddin from the Kebun Raya, Bogor, to work with Ed and me respectively. Our extensive field collecting gear, including methylated spirits for preserving

Calamus periacanthus JD2177, JD2289, JD2291
Calamus plicatus JD2113, JD2114, JD2132, JD2226, JD2337, JD2979
Calamus pogonacanthus JD2107, JD2178, JD2833
Calamus rhomboideus JD2179, JD2820, JD2821
Calamus rhytidomus JD2822, JD2824
Calamus scipionum
Caryota hastata JD2081, JD2801
Caryota mitis
Caryota no JD2153, JD2301, JD2302
Cocos nucifera
Iguanura macrostachya JD2065, JD2071
Korthalsia cheb JD2089, JD2310
Korthalsia echinometra JD2134, JD2828
Korthalsia flagellaris JD2174
Korthalsia laciniosa JD2128, JD2803
Korthalsia rigida
Korthalsia robusta JD2306, JD2307, JD2967
Korthalsia rostrata JD2795
Licuala valida JD2117, JD2129, JD2978
Livistona saribus JD2141
Metroxylon sagu
Nenga pumila var. *pachystachya* JD2188, JD2189, JD2829, JD2834
Oncosperma horridum
Pinanga albescens JD2067, JD2068, JD2073, JD2092, JD2097, JD2787, JD2812, JD2813
Pinanga aristata JD2837
Pinanga keahii JD2845
Pinanga sp. aff. *P. patula* JD2087, JD2091, JD2792, JD2807, JD2846, JD2959
Pinanga sessilifolia JD2069, JD2150, JD2151
Pinanga sp. (spotted on limestone) JD2327
Pinanga sp. JD2847
Pinanga sp. JD2783
Pinanga sp. aff. *P. coronata* JD2887
Pinanga variegata var. *hallieriana* JD2334
Plectocomia mulleri JD2325
Plectocomiopsis geminiflora JD2818, JD2823
Salacca affinis JD2793, JD2794
Salacca dransfieldiana JD2957
Salacca vermicularis JD2093, JD20904, JD2190, JD2790, JD2815
Salacca zalacca

pressed specimens using the Schweinfurth method, large quantities of used newspaper for pressing plants, hanging tags, secateurs and the like, camping equipment and quantities of rice, dried meat and other foodstuffs, were all packed in galvanized tins for shipment by train from Bogor to Surabaya and then by boat from Surabaya to Banjarmasin. The galvanized tins would then be used on the return journey

filled with our pressed specimens in newspaper doused in methylated spirits, with the tin lids sealed with glued tape. The specimens would then be unpacked in the Herbarium in Bogor, pressed again and dried in the Herbarium's drying ovens fueled with charcoal. Of course, these days we use large plastic bags to replace the tins and duct tape for sealing, but the tin method was the tried and tested way of transporting specimens from the field developed in the old Dutch colonial days.

Kuswata, Ed and I flew to Banjarmasin from Jakarta in early November 1971, and while we waited for the cargo, accompanied by Didin and Otjid, we were able to explore Banjarmasin, a fascinating town, in the 1970s largely built in the river delta, where access to houses and shops was most easily accomplished by boat (Fig. 2).

Once united with Didin and Otjid, we set off north in a truck from Banjarmasin, heading for Tanjung and on to Muara Uya, where we settled into a public works department concrete hut at the edge of forest at Jaro Dam. The dam had been newly constructed across a small forest stream to divert water into irrigation ditches for rice paddy in the flat lands at the foot of the Meratus. The hut was rainproof, a bit crowded and we had to adapt to the hard concrete floor for sleeping. However, it proved to be a really excellent base for exploring the adjacent forest.

In those days we did not have GPS units, and maps were poorly detailed and not easy to obtain for perceived security reasons, so we relied on names provided by villagers for localities. I have attempted to pinpoint exactly where we were, using Google Earth and with some success. In broad terms the area we visited in 1971 was bounded on the western side by the north-south karst limestone hogsback hill of Batu Kumpai and on the eastern side by the foothills of the Meratus Mountains with the high point being Gunung Sarempaka (1,237 m above sea level). In between was an alluvial plain newly converted into rice paddy. The dirt road linking South and East Kalimantan passed through this alluvial plain and traversed the mountains into East Kalimantan to the north. Jaro Dam is the water intake for paddy irrigation marked as Dam Nalui or Embung Jaro in Google Earth. At the time of our visit, Jaro Dam had been newly built and the paddy fields had recently been constructed. Present-day tourist images of the whole area suggest that there have been



2. Life in the Mahakam delta, Banjarmasin.

enormous changes in terms of housing, forest clearance and road construction and surfacing. The whole area seems now to be popular with local tourists, to hike, climb mountain peaks or picnicking along the rivers. Back in 1971 most of the hills were still covered with forest but with shifting cultivation encroaching the lower slopes.

In all, we spent eleven days at this base, exploring the forested hills in the main range of the Meratus, as well as the limestone hills that run north-south, to the west of the Meratus. For the last few days, we moved camp north towards the foot of Gunung Sarempaka, spending time at a slightly higher altitude.

Just upriver from Jaro Dam, the forest fringing the riverbanks was rich in palms. In the undergrowth we saw *Iguanura macrostachya*, *Pinanga sessilifolia*, *P. albescens*, *P. variegata* var. *hallieriana* and, more rarely, *Caryota hastata*. *Pinanga albescens* was particularly striking in its fat, oblate, young fruits, white with green veining towards the pronounced beak with the stigmatic remains. This is a handsome species with variably dissected leaves. Superficially more or less identical is *P. sessilifolia*; this species has reflexed inflorescences with spindle-shaped fruit, red when immature but turning black at maturity and borne on the

bright red rachilla. Despite its name, *P. variegata* var. *hallieriana* shows no variegation of the leaves; it is a slender clustering species with rather non-descript variably dissected or entire bifid leaves and small spicate inflorescences. Both *P. sessilifolia* and *P. albescens* were in good ripe fruit. In swampy hollows near the river, there were huge clumps of the viciously spiny stemless *Salacca vermicularis* (Fig. 3), and on nearby slopes, clumps of the short-stemmed *Arenga brevipes* (Figs. 4–6). We were to see a lot of this *Arenga* and *A. undulatifolia*, both very distinctive and easily told apart. There was an abundance of rattans. We came across many individuals of *Calamus paspalanthus*, a widespread Bornean species with unusual morphology; the leaves bear slender, regularly arranged dark green leaflets all held in one plane on the rachis that is covered in dense dark red brown hairs. Most surprising is the ocrea, which is as long as the emerging leaf, straw-colored and papery and soon disintegrating; juvenile plants are extremely ornamental. We also saw a few plants of the elite rattan, *Calamus manan*, that used to be the most important large diameter rattan for furniture manufacture in Sumatra and Peninsular Malaysia, now seriously over-exploited. Unaccountably rare in Borneo, perhaps restricted to the Meratus, the Bornean



3. Fiercely spiny leaf bases of *Salacca vermicularis*.



4. *Arenga brevipes*: leaf fragments ready for the press showing chalky white undersurfaces and young male inflorescence.

plants are generally more slender than those in Peninsular Malaysia and Sumatra and can occasionally be clustered rather than single-

stemmed. Also reaching the forest canopy were the two large clustering species, *Calamus scipionum* and *C. ornatus*.

5 (left). *Arenga brevipes*: male rachilla with flowers at anthesis (they have a strong amyl acetate scent). 6 (right). *Arenga brevipes*: female rachilla with flowers at anthesis.



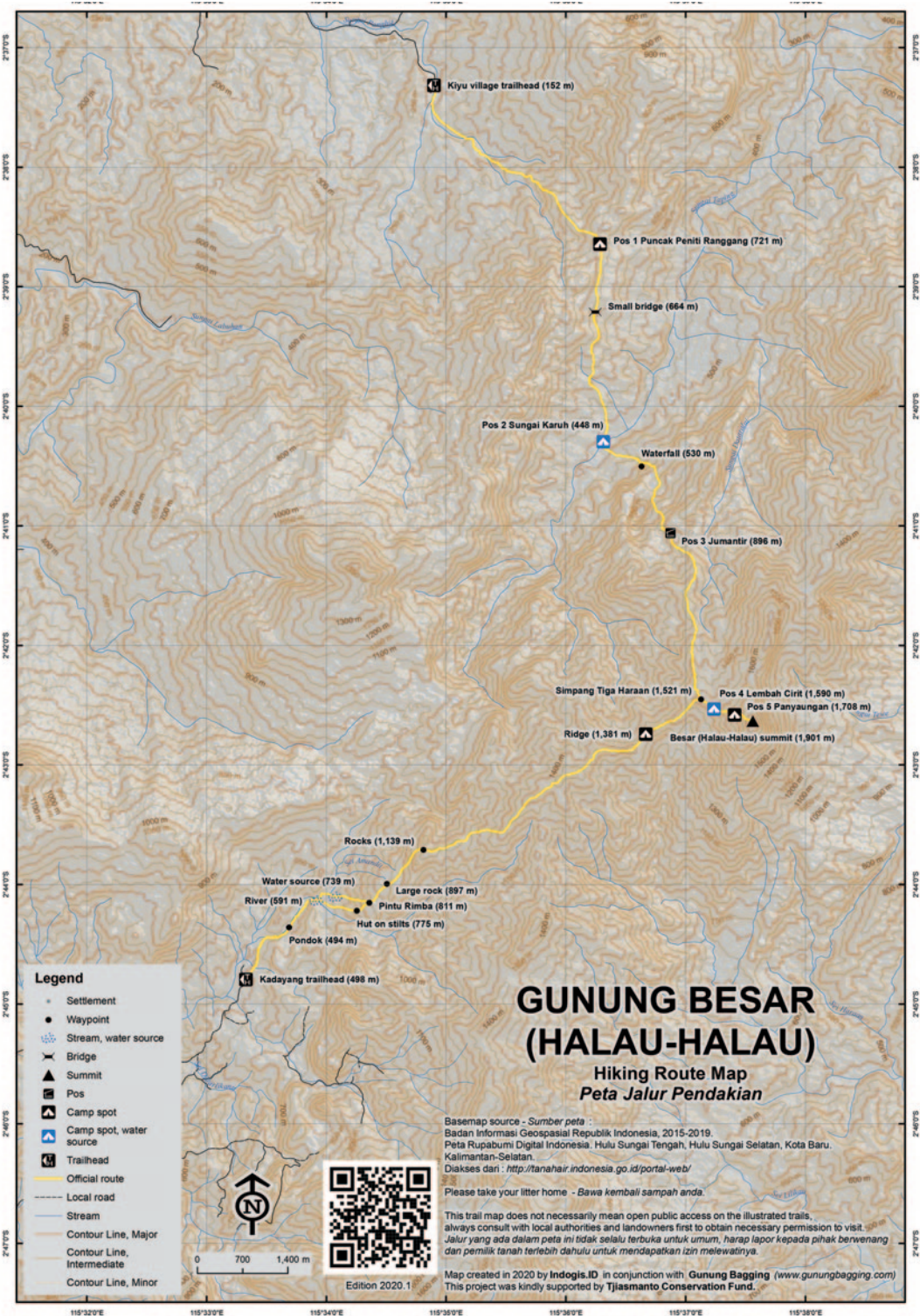


7. The village of Kiyu.

While the most diverse palm flora was to be found in the river valleys and slopes in lowland dipterocarp forest, there were two important palms found surviving on the flatlands in the process of being converted into permanent rice paddy. At the foot of the limestone hills in remnants of secondary alluvial forest, we found one utterly spectacular fruiting giant *Caryota*, which I later identified as *Caryota no* (Dransfield 1974). Making herbarium collections of this monster proved challenging, and it took a couple of days to come up with a strategy. In the end, our tree climber hauled up a strong bamboo culm into the crown of a neighboring rubber tree. Once this was secured, he was able to use it as a bridge into the crown of the *Caryota*. With that secured, he was able to move into the palm crown and cut two leaves, stem surface, and samples of inflorescence with young flowers, immature and mature fruit. The whole exercise took four hours. Just as we finished with our collecting, a pair of Southern Pied Hornbills flew into the crown of the *Caryota* and proceeded to gorge on the ripe fruit. We collected a large quantity of fresh seeds that had to be cleaned. Sheathing our hands in polythene bags, we were able to get rid of the fruit wall, rich in irritant needle crystals, washing them in the river with sand to help remove the flesh. Seeds were sown in the Kebun Raya back in Bogor and were

eventually used to plant an avenue in front of one of the laboratory buildings, while other seed was sent to the Palm Society's Seed Bank and widely dispersed to enthusiasts worldwide. I discussed this palm and other *Caryota* species in an article that appeared in *Principes* in 1974 (Dransfield 1974).

We found one tall mature fan palm remaining in the midst of newly constructed paddy fields in the flat lands between the limestone of Batu Kumpai and the main mountains. We collected this *Livistona* species, and at the time recognized it as the same species I had collected in Ujung Kulon in West Java and in Wai Kambas in South Sumatra, on all occasions growing in low-lying swamplands. I concluded it was *Livistona saribus*, and indeed all three collections have been cited by John Dowe in his monograph of *Livistona* as belonging to *L. saribus* (Dowe 2009). *Livistona saribus* is instantly identifiable by the irregular, deep and shallow splitting of the leaf blade that results in deep divisions of the blade into multifold segments that in turn are divided regularly by shallow and deep splits. The diminutive *L. exigua* from Brunei is the only other species of *Livistona* displaying such deep and shallow splits. Our collection from Kalimantan Selatan was the first and remains the only record of *Livistona saribus* for the island of Borneo,



8. Map showing the route from Kiyu to Gunung Halauhalau (Besar) (reproduced with kind permission of Gunungbagging.com www.gunungbagging.com/besar/, accessed May 2025.

elsewhere so widespread in Indochina and West Malasia. [A collection in Kew from Sabah (Keith 3429) cited by Dowe as *L. saribus* is, in fact, *Pholidocarpus maiadum*, as testified by the label that mentions the large brown fruit so characteristic of *Pholidocarpus*.]



9. *Calamus dumetosus*: habit.

On one day we explored the limestone hills of Batu Kumpai. The karst limestone was covered with rather disturbed forest. Recent photos on Google Earth taken by hikers show that the forest has been seriously trashed, perhaps also burned during prolonged dry seasons. On our visit, the only palm of note was a species of rattan growing high up on limestone ridges, very similar to *Calamus marginatus*; it was recently identified as an

undescribed taxon. Andrew Henderson (2020) described and named this species as *Calamus calciphilus*.

Towards the end of our trip, we moved camp from Jaro Dam to the foot of Gunung Sarempaka. We left early on the morning of 25th November with the help of six porters, climbing up the ridge behind the dam. At first, the palm flora was rather sparse and lacking

10 (top). *Calamus dumetosus*: detail of leaf sheath (note absence of a knee). 11 (bottom). *Calamus dumetosus*: detail of infructescence showing the net-like bracts enveloping the fruit





12. Our camp at Datar Alai at the edge of a forest clearing, Dedy on left, Gede on right, resting after a hard day in the field, the camp walling made of woven leaves of *Arenga brevipes*. Behind Gede note my walking stick made from a stem base of *Calamus manan* that we had collected for the herbarium and hanging on a stump my field basket, made locally from *Korthalsia echinometra* and *Calamus caesius*.

anything we had not already seen and collected. Once we reached an elevation of about 600 m, palms once again became abundant. *Calamus paspalanthus* was particularly common along with *Pinanga variegata* var. *hallieriana*. We also encountered *Calamus crinitus* subsp. *sabut* with its ant galleries formed by collars and slender spines on the leaf sheaths. Farther along the ridge we were following was another viciously spiny *Salacca*, probably *S. vermicularis*, despite its habitat being so different from the valley bottom individuals that we had become familiar with near Jaro Dam. We followed the trail down from the ridge top towards the valley bottom, where huge stands of *Oncosperma horridum* occurred, mostly as solitary individuals but also rarely suckering. There was also an abundance of *Korthalsia robusta*.

Eventually, we reached a clearing in the valley bottom at about 450 m elevation where the river plunged into a sinkhole at the foot of a limestone cliff. Here we made our camp for two nights. There were immense stands of *Arenga undulatifolia* and two individuals of *Caryota no*, one still juvenile, the other dying with spent inflorescences.

However, the most exciting and perplexing find had to be a massive, rather short-stemmed rattan in the undergrowth, distinctive in having no knee on the leaf sheath and no climbing whips (cirri and flagella), which are so characteristic of most rattans. Known locally as *howi tebu bruang*, the bear's sugar cane, the rattan had thick, heavy canes with distinctive short internodes – indeed, looking like sugar cane. Infuriatingly, there were no inflorescences or fruit when I first found this palm. Nevertheless, I collected it. It was not until the following year that I was able to find fertile, female material of this rattan (see below) and two years later that I found male material to the northeast of the Meratus in East Kalimantan and had sufficient material to describe it. Since then, collections have been made scattered throughout Borneo, but it is remarkable that there are no collections prior to 1971, suggesting that despite its massive size and curious morphology the rattan has been overlooked. Eventually I described it as a new genus and species, *Retispatha dumetosa* (Dransfield 1979). *Retispatha dumetosa* was sunk into synonymy by Henderson and Floda (2015); nevertheless, *Calamus dumetosus* is a remarkable and phylogenetically isolated species (Kuhnhäuser et al. 2021).



13 (left). Dedy holds a specimen of *Salacca dransfieldiana*. 14 (right). Male inflorescence of *Salacca dransfieldiana*.

We had run out of time, and possibly energy, and despite not having attempted the summit of Gunung Sarempaka, we left with porters back to the familiar hut at Jaro Dam for a night and packed and sealed the tins of specimens and equipment. On the following day, our truck arrived, and we returned to Banjarmasin in the knowledge that there was so much more to explore in these mountains.

Gunung Halauhalau

In October 1972, we made our second expedition to the Meratus Mountains, this time aiming for the central area surrounding the highest peak, Gunung Halauhalau (also called Gunung Besar). Our group consisted of Dr. Mien Rifai (the Keeper of the Bogor Herbarium and a passionate mycologist), Dedy Darnaedi (at the time a junior staff member of the Herbarium), I Gede Ranten (staff of Kebun Raya, Bogor), Prof. Charles Lamoureux (University of Hawaii, on sabbatical leave in Bogor) and myself. Mien, Charles and I flew to Banjarmasin while Dedy and Gede came by boat, as in the first expedition, with all the plant-collecting and camping equipment and food. Once united in Banjarmasin, we set off

by truck to the north, the countryside severely drought-stricken from an El Niño-influenced long dry season. There had been widespread grass fires, and village orchards showed serious drought damage. The atmosphere was heavy with smoke, and the distant peaks of the Meratus were obscured by haze.

After several false leads, we eventually took the advice of the Bupati (district governor) of Hulu Sungai Selatan in Kandungan and chose to set up our base camp in a small village, Kiyu. Our transport dropped us off at Batu Tangga, mercifully greener as there had been several rain showers here. We spent the night in the house of a local police officer. The next morning, we arranged for 25 porters to carry our equipment and supplies. We followed a clear river upstream through magnificent limestone country for the first part of the day, through orchards and secondary forest and then on to igneous-derived soils. On the way, we saw *Caryota no*, *Arenga pinnata*, *A. brevipes* and *A. undulatifolia*, this in amazing abundance, *Salacca vermicularis*, *S. affinis*, *Calamus caesius*, *C. manan*, *C. ornatus*, *C. scipionum*, *C. pogonacanthus*, *C. hallierianus*, *C. gracilipes*, *Korthalsia robusta*, *K. rostrata* and *K.*



15. *Pinanga aristata*, distinctive in its spirally arranged small yellow fruit that ripen bright red.



16. Juvenile leaves of *Pinanga aristata* can be beautifully mottled.

laciniosa, all palms that we had seen in abundance at Jaro Dam. In the late afternoon, in a state of dehydration, we reached Kiyu, a small village with scattered houses and the forested hills of the Meratus mountains still a long way off (Fig. 7). Kiyu was occupied by people of the Orang Ulu Sungai Selatan indigenous group, who had been moved out of their semi-nomadic settlements near the foot of Gunung Halauhalau, generally called Datar Alai, by the local government for easier administrative purposes. The River Alai seems to be the same as Sungai Karuh on modern maps. The Bupati, for some reason unknown to us, considered that we should be accompanied by a policeman, armed with a rifle. This seemed quite unnecessary, but he was pleasant enough company. Our village hosts were friendly, soft-spoken people with an intimate knowledge of the forest and with highly developed skills in rattan weaving, manifest in a wonderful array of carrying baskets and mats. The headman, Maikama, accompanied us throughout our daily trips into the forest together with other villagers, and then later we moved camp with porters to Datar Alai, where we set up a temporary camp. This provided the base for a successful ascent of Gunung Halauhalau (Fig. 8).

The area surrounding Kiyu was rich in palms, which we explored during the first few days

of the expedition. Here we collected many of the palms that we had seen further north at Jaro Dam. Once we felt that we were seeing nothing additional, it was time to move camp to Datar Alai. Datar Alai proved to be even more interesting, introducing me to montane species, some of which represented new records of species described from Kinabalu or elsewhere in the mountains of Borneo. The greatest excitement for me was discovering an individual of the mystery rattan of Gunung Sarempaka with infructescences, each fruiting rachilla wrapped in net-like bracts – inspiring the generic name *Retispatha* (Figs. 9–11).

Our temporary camp consisted of a hut, roofed with a tarpaulin and with walling made of the leaves of *Arenga brevipes*, the chalky buff-white undersides making a wonderful contrast to the dark green upper leaf surface when plaited into walling (Fig. 12). In the flat area around the camp, we discovered a diminutive species of *Salacca* with entire-bifid leaves. It had minute male inflorescences. Among the smaller species in the genus, it was subsequently named *Salacca dransfieldiana* by Johanis Moge (Mogea 1980) (Figs. 13 & 14). *Pinanga albescens* and the superficially very similar *P. sessilifolia* were abundant in the flatter areas in Datar Alai as at Jaro Dam.

On 23rd October, Dedi, our guide Maikama and assistant Wis and I left early in the

morning to attempt the climb to the summit of Gunung Halau-Halau. We took with us a small tent, a small tarpaulin and provisions for three days and simple plant collecting gear. We followed the path along the River Alai and

branched off to begin climbing. We were immediately in wonderful, palm-rich forest, with great thickets of *Arenga brevipes* and much *Pinanga aristata* (Figs. 15 & 16) and *Areca kinabaluensis*, both first records in Kalimantan

17. The summit of Gunung Halauhalau.





18. *Korthalsia robusta*: ocreas occupied by ants.

for palms described from Kinabalu. As we climbed higher, the forest changed to upper hill dipterocarp forest with huge trees of *Agathis borneensis*. Palms consisted mostly of *Pinanga aristata*, a species of *Pinanga* possibly related to *P. patula* with strange flagelliform branches emerging from the basal nodes and bearing small plants at their tips, *Calamus ater*, the new mystery rattan (*Calamus dumetosus*) and *Calamus manan*. Finally, we emerged into lower montane forest with an abundance of *Plectocomia mulleri*, a slender *Calamus* seemingly related to *C. heteroideus* from Java and still not determined. I have attempted to match it with Henderson's recent monograph (2020) but without success. It appears to be undescribed. Our trail dropped down into a very humid valley with much *Pinanga aristata* and another slender clustering *Pinanga*, remarkable for its simple spikes bearing disproportionately large fruits with thick sweet mesocarp. Subsequently, I identified this as *Pinanga keahi*, at the time otherwise known only from Kinabalu in Sabah and yet another new record for this part of Borneo.

We made camp near the remains of a helicopter that had crashed here some years previously. The following morning, we set off for the summit, climbing steeply through lower montane forest with thickets of

Plectocomia mulleri and *Calamus* sp. aff. *C. heteroideus* and then emerging onto a steep, sharp ridge between Gunung Halauhalau Bini and Gunung Halauhalau Laki with Upper Montane Forest – very mossy but with rather few ground herbs. At the lip of the ridges, we found a densely clustering *Pinanga* with rather robust leaves with narrow leaflets and sometimes with branches from the internodes (JD2887). This palm remains unidentified, to my shame.

We wound our way up through the twisted, gnarled trees and suddenly emerged into a small clearing, and the swirling mist cleared, allowing a view of the precipices of Gunung Halahallau Laki, our goal (Fig. 17). The upper montane forest here was dominated by *Phyllocladus hypophyllus*, *Tasmannia piperita* and a *Dacrydium* species, all trees of austral affinity that are widespread in upper montane forest in Borneo. We collected a beautiful rhododendron, superficially similar to *R. jasminiflorum* from Peninsular Malaysia with fragrant white flowers. Some years later George Argent in Edinburgh recognized this as undescribed, and we named it *Rhododendron alborugosum* (Argent & Dransfield 1989).

At last, we reached the summit, and in gaps in the clouds we could see Datar Alai, the



19. Our field helper Wis struggles to hold the great weight of a fruiting stem of *Korthalsia robusta*.

lowlands around Barabai and to the east Kota Baru. Back at our simple camp, we prepared the plants and wrote up our field notes and retired as it became dark.

On our way back, we followed the ridge back down but this time veered off to the south to Gunung Batu Berdinding, a limestone hogsback running parallel to Datar Alai, joining the Alai valley at the point where the Alai river plunges down a spectacular five-tiered waterfall. In the valley bottom, there was much evidence of former settlements and old clearings, the traditional homeland of our friends from Kiyu. Finally, we reached our camp at Datar Alai. It had been a wonderful three days, and as I write more than 50 years later, I marvel at how fit I must have been.

We had a short day to round off our collecting in Datar Alai, collecting magnificent fruiting *Korthalsia robusta* (Figs. 18 & 19). The cluster of inflorescences that terminate the growth of the stem causes the stem apex to hang out of the forest canopy. This species is widespread in Borneo and is remarkable for its diverging in-rolled ocreas in which ants make their nests

and also husband aphids for honeydew. When disturbed, the ants set up an alarm call, banging their mandibles in unison on the dry ocreas. This eerie sound is one of the marvels of the Bornean forest. *Korthalsia hispida* shares this character. We were also able to collect good material of *Licuala valida*, *Calamus marginatus* and *Calamus crinitus* subsp. *sabut*.

The following day, porters arrived, and we packed up, making our way back to Kiyu (Fig. 20). Sadly, the mountains were covered in mist, so there were no long-distance views. In the afternoon, villagers came to our hut with a wonderful variety of fine baskets and matting, well displaying their consummate skill in rattan weaving. Luckily, they were for sale, and we came away with a great variety of beautiful rattan wares (Fig. 21).

So ended our second trip to the Meratus mountains. Both trips had been immensely rewarding for me. I had experienced a diverse palm flora that was poorly represented in herbaria, had discovered new species and made new records of palms previously thought to be restricted to the mountains of northern



20. Villagers from Kiyu resting as they transported our gear and parcels of pressed specimens back from Datar Alai to Kiyu; Dr Mien Rifai at front right.

Borneo. Some of my collections remain unidentified. Since our expeditions, there has been much clearing of the forest. The lower slopes of the mountains have been denuded by shifting cultivation and the limestone hills, generally difficult to access, appear to have been burned, with little forest remaining and much degraded. The lowland areas appear now to have excellent road access, villages have sprung up and appear prosperous, and the rivers and waterfalls appear to be popular tourist spots, given the large numbers of photographs posted in Google Earth, all very different from the landscape I experienced in the 1970s.

Acknowledgments

Daniel Quinn of Gunungbagging.com gave permission to reproduce the detailed map of Gunung Halauhalau. I thank Bill Baker and Ben Kuhnhäuser for help with images and maps. Fifty years on, I still feel immensely grateful to the villagers of Kiyu who made our trip to Gunung Halauhalau so productive and enjoyable.

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21. *Butah*, carrying basket/rucksack made from split *Korthalsia echinometra* and bound with split *Calamus caesius*, used by local people in the Meratus Mountains; the shoulder straps woven into the body of the basket are unusual and specific to this type of basket.

Index to Volume 69

- A new species of fossil palm described for Australia 27
- A population assessment of six threatened palm species in Sainte Luce, southeast Madagascar: a glimmer of hope? 31
- A unique anatomical character distinguishes *Phoenix atlantica* from other *Phoenix* species 142
- Acoelorrhaphe wrightii* 120
- Acrocomia aculeata* 123
- Adonidia* 6, 7, 9, 11, 12, 19
- Adonidia dransfieldii* 11
- Adonidia merrillii* 11, 12
- Adonidia zibabaoa* 3, 5–7, 9, 11, 12, 14,
- Adonidia zibabaoa*, a remarkable new palm species from Samar Island, Philippines 5
- Adorador, J.T., V. Perez-Calle, Z.D. Meneses-Adorador, S. Bellot, W.J. Baker & E.S. Fernando: *Adonidia zibabaoa*, a remarkable new palm species from Samar Island, Philippines 5
- An informal check on the health of the endangered palms of Fiji 57
- Archontophoenix* 27, 29
- Archontophoenix alexandrae* 29
- Areca catechu* 184
- Areca concinna* 102
- Areca kinabaluensis* 184, 197
- Areca triandra* 102
- Arenga* 108, 160
- Arenga brevipes* 184, 186, 188, 194, 196, 197
- Arenga pinnata* 184, 194
- Arenga undulatifolia* 184, 186, 193, 194
- Arneaud, L.L.: The distribution of *Nipa* palms (*Nypa fruticans*) in Trinidad and Tobago 21
- Astrocaryum* 110
- Astrocaryum mexicanum* 113, 120
- Attalea* 110, 135, 137
- Attalea butyracea* 113
- Attalea cohune* 120, 123, 124
- Attalea maripa* 141
- Attalea speciosa* 141
- Attalea eichleri* 137
- Aureglia, L., M. Rakotoarinivo & B. Vila: The palms of southeast Madagascar: Fort-Dauphin as a *Ravenea* hotspot 161
- Bacon, C.D., S. Brewer, S. Eshleman, K. Prufer & M. Robinson: Human legacies on palms in Belize: 118
- Bactris gasipaes* 68, 70
- Bactris mexicana* 120, 121
- Baker, W.J., as co-author 5
- Balaka* 7, 11, 63
- Balaka diffusa* 57–61, 63
- Balaka longirostris* 57, 59, 71
- Balaka macrocarpa*, 59
- Balaka microcarpa* 57, 59, 63, 64, 65, 79
- Balaka seemannii* 59, 74
- Balaka streptostachys* 59
- Baldini, R., as co-author 83
- Beccariophoenix madagascariensis* 32, 35, 37–42, 169, 170
- Bellot, S., as co-author 5
- Bradley, G., as co-author 31
- Brahea* 109
- Brewer, S., as co-author 118
- Calamus* 183
- Calamus ater* 184, 198
- Calamus caesius* 184, 193, 194, 201
- Calamus calciphilus* 184, 192
- Calamus crinitus* subsp. *crinitus* 184
- Calamus crinitus* subsp. *sabut* 184, 193, 199
- Calamus disjunctus* 184
- Calamus dumetosus* 184, 191, 192, 193, 198
- Calamus erioacanthus* 184
- Calamus geniculatus* 184
- Calamus gracilipes* 184, 194
- Calamus hallierianus* 184, 194
- Calamus* sp. aff. *C. heteroideus* 184, 198
- Calamus hirsutus* subsp. *korthalsii* 184
- Calamus javensis* 184
- Calamus longipes* 184
- Calamus manan* 184, 186, 193, 194, 198
- Calamus marginatus* 184, 192, 199
- Calamus melanochaetes* 184
- Calamus oblongus* subsp. *elongatus* 184
- Calamus ornatus* 184, 188, 194
- Calamus paspalanthus* 184, 186, 193
- Calamus periacanthus* 184
- Calamus plicatus* 185
- Calamus pogonacanthus* 185, 194
- Calamus rhomboideus* 185
- Calamus rhytidomus* 185
- Calamus scipionum* 159, 185, 188, 194
- Calamus vitiensis* 59, 74
- Calypstrogyne ghiesbreghtiana* 113, 120, 123
- Caryota* 108, 160, 189
- Caryota hastata* 160, 185, 186
- Caryota mitis* 185
- Caryota no* 185, 189, 193, 194
- Chamaedorea* 109, 110, 119, 123
- Chamaedorea alternans* 113
- Chamaedorea arenbergiana* 113
- Chamaedorea costaricana* 120
- Chamaedorea ernesti-augusti* 113, 119, 120
- Chamaedorea linearis* 4
- Chamaedorea neurochlamys* 120, 121
- Chamaedorea oblongata* 120
- Chamaedorea pinnatifrons* 4, 113
- Chamaedorea schippii* 120
- Chamaedorea seifrizii* 120
- Chamaedorea tepejilote* 113, 120

- Chamaedorea tuerckheimii* 113, 114
Chrysalidocarpus decaryi 170, 172
Chrysalidocarpus mananjarensis 165
Chrysalidocarpus prestonianus 33, 35, 36, 38–42, 165
Chrysalidocarpus psammophilus 33, 36, 38–42
Chrysalidocarpus saintlucei 33, 36–42, 165
Clinostigma exorrhizum 59, 71, 73, 74, 75
Cocos 84, 86–89, 92, 93, 95
Cocos nucifera 86, 92–96, 98, 160, 167, 185
Cocos nucifera var. *nucifera* 83, 89–93, 95–98
Cocos nucifera var. *palmyrensis* 55, 83–99
Colpothrinax 109, 114
Colpothrinax aphanopetala 114
Colpothrinax chiapensis 114
Colpothrinax cookii 107, 109–116, 120
Colpothrinax cookii: A new record for Mexico 109
Colpothrinax wrightii 114
Copernicia 114
Copernicia macroglossa 102
Corypha umbraculifera 50
Cryosophila stauracantha 120, 123
Cyphosperma naboutinense 57, 59, 62, 63, 74, 79
Cyphosperma tanga 57, 59, 69, 70, 71
Cyphosperma trichospadix 59, 71, 72, 74, 77, 79
Desmoncus chinantlensis 120, 122
Dowe, J.L.: A new species of fossil palm described for Australia 27
Dransfield, J., as co-author 49
Dransfield, J.: The palm flora of the Meratus Mountains in Kalimantan, Indonesia as observed in the 1970s 183
Duffell, J., as co-author 31
Dypsis brevicaulis 3, 33, 36, 38–42, 165
Dypsis commersoniana 167
Dypsis elegans 164, 165
Dypsis nodifera 169
Dypsis pinnatifrons 165
Dypsis scottiana 33, 34, 36–42
Elaeis guineensis 165, 170
Eshleman, S., as co-author 118
Euterpe pectoratoria 120
Evans, N., as co-author 31
Fernando, E.S., as co-author 5
Gaussia maya 120
Geonoma 119, 154
Geonoma deversa 120
Geonoma interrupta subsp. *magnifica* 120, 123
Geonoma pinnatifrons subsp. *mexicana* 120
Gerrish, J., as co-author 83
Gomes, I., as co-author 142
Gómez Domínguez, H., as co-author 109
Gregório Bondar 135
Griffith, M.P., as co-author 177
Griffith, M.P., F. Stauffer, K. McLaughlin, J. Gerrish & R. Baldini: *Cocos nucifera* var. *palmyrensis*, a unique native coconut from Palmyra Atoll 83
Grinage, A.D, K.A. Paralta & M.M. Salinas-Rodríguez: *Sabal tamaulipensis*, a new species from northeastern Mexico 127
Henderson, A.: Gregório Bondar 135
Heterospathe 6
Heterospathe longipes 59, 74, 76–79
Heterospathe phillipsii 57, 59, 79
Human legacies on palms in Belize: 118
Hyde Roberts, S., N. Evans, L. Kramer, L. Jhaveri, J. Duffell, Q.M. Parker, G. Bradley & H.T. Longoso: A population assessment of six threatened palm species in Sainte Luce, southeast Madagascar: a glimmer of hope? 31
Hydriastele boumae 59, 74
Hydriastele vitiensis 55, 59, 68, 70
Iguanura macrostachya 185, 186
Iriartella 108
Iriartella setigera 108
Iriartella stenocarpa 108, 154
Jack B. Fisher (1943–2014) 49
Jailoloa 6, 7, 11
Jhaveri, L., as co-author 31
Johannesteijsmannia 70
Kerriodoxa 50
Khoddamzadeh, A.A., as co-author 177
Korthalsia 160
Korthalsia cheb 185
Korthalsia echinometra 185, 193, 201
Korthalsia flagellaris 185
Korthalsia hispida 199
Korthalsia laciniosa 185, 196
Korthalsia rigida 185
Korthalsia robusta 185, 194, 198, 199
Korthalsia rostrata 185, 193, 194
Kramer, L., as co-author 31
Licuala ramsayi 4
Licuala valida 185, 199
Linospadix 27
Livistona 189
Livistona exigua 108
Livistona exigua 189
Livistona saribus 185, 189, 190
Lock, M., as co-author 57
Lock, M., M. Lock & D. Watling: An informal check on the health of the endangered palms of Fiji 57
Lock, M.: Palm Profile: *Pritchardia thurstonii* in the Lau Islands of Fiji 82
Longoso, H.T., as co-author 31
Maki, E. Palm Profile: Palmiche (*Sabal mexicana*) in Guanacaste, Costa Rica 45
Manjekia 6, 7, 11
Martínez-Martínez, M.G., as co-author 109
McLaughlin, K., as co-author 83
Meneses-Adorador, Z.D., as co-author 5

- Metroxylon sagu* 185
Metroxylon vitiense 57, 59, 66–68, 70
 Moreno Méndez, G., as co-author 109
Nenga pumila var. *pachystachya* 185
Neoveitchia storckii 57, 59, 65, 67, 68, 79
 Noblick, L. & I. Gomes: A unique anatomical character distinguishes *Phoenix atlantica* from other *Phoenix* species 142
 Nuñez, L., as co-author 177
Nypa fruticans 3, 21–25
Oncosperma horridum 185, 193
Orania 6
Orania trispatha 165, 166
 Palm Profile: *Iriartella stenocarpa* 154
 Palm Profile: Palmiche (*Sabal mexicana*) in Guanacaste, Costa Rica 45
 Palm Profile: *Pritchardia thurstonii* in the Lau Islands of Fiji 82
Palmoxydon queenslandicum 27
 Paralta, K.A., as co-author 127
 Parker, Q.M., as co-author 31
 Perez-Calle, V., as co-author 5
 Pérez-Farrera, M.A., H. Gómez Domínguez, D. Villar-Morales, M.G. Martínez-Martínez & G. Moreno Méndez: *Colpotherinax cookii*: A new record for Mexico 109
Phoenicites 27
Phoenicites insula-lacuna 27, 28
Phoenix 142–144, 146–152
Phoenix atlantica 107, 142–151, 153
Phoenix canariensis 143
Phoenix dactylifera 142–146, 148–150
Pholidocarpus 190
Pholidocarpus maiadum 190
Physokentia petiolata 59, 71
Physokentia thurstonii 59, 74
Pinanga 185, 198
Pinanga albescens 185, 186, 196
Pinanga aristata 185, 195–198
Pinanga coronata 63, 65
Pinanga sp. aff. *P. coronata* 185
Pinanga keahii 185, 198
Pinanga sp. aff. *P. patula* 185, 198
Pinanga sessilifolia 185, 186, 196
Pinanga variegata var. *hallieriana* 185, 186, 193
Plectocomia mulleri 185, 198
Plectocomiopsis geminiflora 185
Ponapea 11
Pritchardia 82, 114
Pritchardia thurstonii 55, 59, 82
 Prufer, K., as co-author 118
Pseudophoenix sargentii 160
Pseudophoenix vinifera 160
 Rakotoarinivo, M., as co-author 161
Raphia farinifera 165
Ravenea 161, 162, 165, 171, 173
Ravenea conferta 169, 170, 171, 173
Ravenea cycadifolia 159, 166, 167, 171, 173
Ravenea declivium 171
Ravenea dransfieldii 164–166, 171
Ravenea hypoleuca 165, 171
Ravenea julietiae 169, 172
Ravenea krociana 169
Ravenea lakatra 165, 166, 171, 173
Ravenea musicalis 167–169, 171, 173
Ravenea robustior 165
Ravenea sabiranensis 163, 165
Ravenea xerophila 171, 173
Reinhardtia 110
Reinhardtia elegans 113, 114
 Robinson, M., as co-author 118
Roystonea borinquena 160
Sabal × *brazoriensis* 128
Sabal 45, 109, 127, 181, 182
Sabal etonia 133
Sabal mauritiiiformis 45, 46, 120, 123, 124
Sabal mexicana 45, 46, 127, 133
Sabal miamiensis 133, 159, 177–182
Sabal miamiensis: Discovery of a new wild population and restoration efforts 177
Sabal minor 127–129, 131–133
Sabal palmetto 133
Sabal tamaulipensis 127–133
Sabal tamaulipensis, a new species from north-eastern Mexico 127
Salacca 50, 193
Salacca affinis 185, 194
Salacca dransfieldiana 185, 194, 196
Salacca vermicularis 185, 187, 193, 194
Salacca zalacca 185
 Salinas-Rodríguez, M.M., as co-author 127
 Sanín, M.J., as co-author 177
Schippia concolor 120
Serenoa 181
 Stauffer, F., as co-author 83
Syagrus 108, 137
Syagrus coronata 137, 138
Syagrus glaucescens 108
Syagrus harenae 108
Syagrus schizophylla 140
Syagrus vagans 139
Synechanthus fibrosus 113, 120
 The distribution of Nipa palms (*Nypa fruticans*) in Trinidad and Tobago 21
 The palm flora of the Meratus Mountains in Kalimantan, Indonesia as observed in the 1970s 183
 The palms of southeast Madagascar: Fort-Dauphin as a *Ravenea* hotspot 161
Thrinax radiata 120
 Tucker, D.A., M.J. Sanín, M.P. Griffith, S. Valenzuela, L. Nuñez & A.A. Khoddamzadeh: *Sabal miamiensis*: Discovery of a new wild population and restoration efforts 177
 Tucker Lima, J.M.: Palm Profile: *Iriartella*

<i>stenocarpa</i> 154	Villar-Morales, D., as co-author 109
Valenzuela, S., as co-author 177	<i>Vonitra utilis</i> 165
<i>Veitchia</i> 7, 11	<i>Wallaceodoxa</i> 6, 7, 11
<i>Veitchia filifera</i> 59	<i>Wallichia</i> 160
<i>Veitchia joannis</i> 59	Watling, D., as co-author 57
<i>Veitchia simulans</i> 59, 74, 76	<i>Wodyetia birfurcata</i> 160
<i>Veitchia vitiensis</i> 59	Zona, S & J. Dransfield: Jack B. Fisher (1943–
Vila, B., as co-author 161	2014) 49

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