



PALMS

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FRONT COVER

Heterospathe glauca. Crownshaft and infrapetiole inflorescence. Note the brown tattering upper margins of the crownshaft. See article by B.G. Kuhnhäuser et al., p. 109. Photo by B.G. Kuhnhäuser.

BACK COVER

Zach Pezzillo encouraging a cluster of hāwane (*Pritchardia* fruits) from *P. woodii* trees on a wet morning. See article by M. Opgenorth et al., p. 133. Photo by Mike Opgenorth.

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Open flowers and unripe fruits on *Areca vestiaria*. See article by B.G. Kuhnhäuser et al., p. 109. Photo by B.G. Kuhnhäuser.

PALM NEWS



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The red palm weevil (*Rhynchophorus ferrugineus*), an invasive exotic beetle, continues its rampage through agronomic and ornamental palms in the Mediterranean region and Middle East. Because its larvae burrow deep into the trunks and terminal buds of palms, they are difficult to treat with conventional contact pesticides. One control strategy being explored is the sterile insect technique, in which sterile males mate with wild-type females, who subsequently lay infertile eggs. The success of the sterile insect technique depends on sterile males mating as often and as effectively as fertile males. A recent paper by M. Cristofaro et al. (*Insects* 14: 661. <https://doi.org/10.3390/insects14070661>) demonstrates that

males sterilized with gamma radiation are fully competitive with non-irradiated males and that mating performance is not negatively affected. These results show that the sterile insect technique can be one more strategy in the ongoing battle against red palm weevil.

News broke this summer that a man in Hawaii opened a bag of **Miracle Gro garden soil and found fifty larvae of the coconut rhinoceros beetle (*Oryctes rhinoceros*)**. The bag was purchased locally, and it was stored at his home for some time before he made the startling discovery. The Hawaiian Department of Agriculture inspected the vendor and found no other infested bags. The bag likely became infested during storage. Oahu is the epicenter of the coconut rhinoceros beetle outbreak in Hawaii, but the beetle has been detected on other islands. The beetle attacks many species of palms besides coconut. This event shows how invasive species can hitchhike not just on live plants but in bagged soil products and other organic materials.



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A study of the molecular genetics of the three species of *Parajubaea* was recently published by Nicolás Peñafiel Loaiza and colleagues (*Evolutionary Applications* 17:e13765. 2024. <https://doi.org/10.1111/eva.13765>). The study found no evidence to suggest that *P. cocoides*, a palm unknown in the wild, was derived from any extant wild populations. Its origin is still a mystery. Moreover, the authors found no support for maintaining *P. sunkha* as distinct from *P. torallyi*. Wild populations isolated in intermountain valleys have low genetic diversity, a finding with implications for conservation. This study was funded, in part, by a grant from the International Palm Society.



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The Forgotten Palm Flora of Gunung Gamalama, an Active Indonesian Volcano

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The Indonesian island of Ternate is known for its role in the spice trade, yet its unusual palm flora has almost become forgotten. On a recent visit to Ternate's active volcano, Gunung Gamalama, we rediscovered several poorly known palms.

Ternate is a small island in the province of North Maluku, Indonesia, that measures little more than 10 km in diameter. It is dominated by Gunung Gamalama, a near-conical active volcano that reaches a height of 1714 m and last erupted in 2018 (Global Volcanism

Program 2024). Despite its small size and the constant threat from volcanic activity, Ternate played a central role in the global trade of cloves and nutmeg from the 14th to the 18th century (Muller 1997). Still today, Ternate hosts major spice plantations and the largest population centre in North Maluku and acts as the main gateway to the region. Most of the island is dominated by settlements (28%) and plantations (60%), which cover the lowlands and lower slopes of Gunung Gamalama, whereas forest is largely constrained to the upper slopes and covers only approximately 8 km² (10%) of the island (Sarihi et al. 2020). In 1999, forest above 900 m above sea level was designated as a conservation area (Hutan Lindung, or Protected Forest) in which human intervention, such as logging, is forbidden. Besides its economic significance, Ternate played a crucial role in the first explorations of the biodiversity of the Malay Archipelago and the development of the theory of evolution: from 1858 to 1861, it was Alfred Russell Wallace's

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1. Lake Tolire and the volcano Gunung Gamalama. Photo: B.G. Kuhnhäuser.

main base during his travels around Maluku and New Guinea, and here he wrote in 1858 the famous “Ternate essay” that prompted Charles Darwin to publish his theory of evolution by natural selection (Darwin & Wallace 1858). Soon after, Wallace was followed by the botanist Odoardo Beccari, who “was struck by the large palm trees that I could see on the Peak of the Volcano of Ternate from the sea” [translated from Italian] (Beccari 1877). Beccari collected several palms on Gunung Gamalama in November 1874, including the types of *Ptychosperma musschenbroekianum* Becc. (synonym of *Heterospatha glauca* (Scheff.) H.E.Moore) and *Hydriastele moluccana* (Becc.) W.J.Baker & Loo (Beccari 1877). Despite these promising beginnings, the Ternate palm flora has largely sunk into obscurity following Beccari’s explorations. *Heterospatha glauca* and *Hydriastele moluccana* remain enigmatic species that are only known from a few herbarium specimens (Gardiner et al. 2012, Petoe et al. 2018).

During field work in Maluku in November 2023, we conducted a survey of the palms of Ternate. Initial exploration along the coastal road circling the island yielded only two native

palms, the sago palm (*Metroxylon sagu* Rottb.) and the mangrove palm (*Nypa fruticans* Wurmb), both of which are widespread across Indonesia. In addition, we saw three cultivated palms. Coconut palms (*Cocos nucifera* L.) were widely grown in plantations in coastal areas and lowlands. In contrast, the betel nut palm (*Areca catechu* L.) and sugar palm (*Arenga pinnata* (Wurmb) Merr.) were cultivated more locally in villages. Of these, we found *Arenga pinnata* also growing in a semi-wild state near a residential area. At Lake Tolire on the northwestern slopes of the island (Fig. 1), we did not encounter any further palms, and neither could we see from the lowlands any palms growing on the peak of Gunung Gamalama.

Unaware of Beccari’s explorations at the time and discouraged by our meager findings, we were almost ready to accept that Ternate had either never hosted any other palms, or that they had been eradicated by volcanic eruptions or deforestation to make space for the extensive spice plantations on the mountain. Then, however, a villager in Jikomalamo, northwestern Ternate, told us of a rattan growing further inland, prompting



2. *Heterospathe glauca*. Habit. Photo: B.G. Kuhnhäuser.



3. *Heterospathe glauca*. Habit. Photo: B.G. Kuhnhäuser.



4. *Heterospathe glauca*. Immature infructescence. Photo: S. Suparman.



5. *Heterospathe glauca*. Fallen ripe fruit. Photo: B.G. Kuhnhäuser.

new hope that more palms may be found on the island.

The palms of Gunung Gamalama

To find out whether any other palms occurred further up the slopes of Gunung Gamalama, we decided to climb the volcano. Starting in the village of Moya on the eastern slopes of the mountain at around 400 m above sea level, we followed the steadily ascending summit trail through groves of nutmeg and cloves. During the first half of the ascent, the path led through plantations with abundant evidence of human disturbance and cultivation, and no new palms were found. At ca. 900 m, however, the protected forest area began, and we entered a lush montane tropical rainforest with an extraordinary palm flora consisting of four species.

The most exciting find was *Heterospathe glauca*, which, unlike almost all other *Heterospathe* species, has a crownshaft and strictly infrafoliar inflorescence, i.e. the inflorescence emerges below the crownshaft (Figs. 2 & 3; Front Cover). *Heterospathe glauca* is a poorly known palm from Maluku that was depicted in cultivation more than a century ago (Scheffer 1876) but has remained a mystery because the available herbarium material is inconclusive (Gardiner et al. 2012) and its phylogenetic relationships are unresolved. The species we encountered is single-stemmed, slender and

grows in the forest midstory to a height of ca. 5–15 m (Figs. 2 & 3). It has a grayish green, bulging crownshaft that is brown and tattering at the upper margins and the transition to the petiole (Front Cover). The leaves are horizontal to ascending, with numerous horizontal to arching leaflets. The inflorescences are widely or narrowly spaced and spread horizontally or ascendingly. They have a pronounced peduncle to ca. one third of their length and a clear main axis from which long slender branches spread in all directions in up to two orders of branching. The fruit are globose, green when young and bright red when ripe (Figs. 4 & 5), and are very big compared to most other species of the genus. The only other known *Heterospathe* with a crownshaft and strictly infrafoliar inflorescence is *Heterospathe barfodii* L.M.Gardiner & W.J.Baker from eastern New Guinea, which has a white crownshaft, young inflorescences that are deep purple and much smaller fruit. It is unclear how closely related *Heterospathe glauca* and *H. barfodii* are because until now, there has been insufficient material to compare them taxonomically or phylogenetically.

The only clearly emergent tree palm that we encountered was *Hydriastele moluccana*, a single-stemmed and relatively slender palm of ca. 10–15 m height that was common throughout most of the montane rainforest (Fig. 6). It was distinguished from other palms



6 (top). *Hydriastele moluccana*. Habit. 7 (bottom). *Hydriastele moluccana*. Inflorescence. Photos: B.G. Kuhnhäuser.

by its strongly drooping leaflets, robust gray crownshaft and short, broom-like inflorescences emerging directly beneath the crownshaft (Figs. 6–8). Furthermore, the crown is densely crowded with leaves emerging in all directions, and the fruits are small and

ellipsoid. *Hydriastele moluccana* is a rarely collected species from North Maluku that has a close morphological affinity to the better-known *H. costata* Bailey from New Guinea (Essig 1982, Petoe et al. 2018, Baker et al. 2024). The main difference between both



8 (top). *Hydriastele moluccana*. Fallen dead inflorescence. 9 (bottom). *Hydriastele moluccana*. Fruit on fallen inflorescence. Note the longitudinal vascular bundles exposed on the fruit in the right. Photos: B.G. Kuhnhäuser.

species is said to be in the conspicuousness of the longitudinal vascular bundles of the fruit, which are very pronounced and widely spaced in *Hydriastele costata* and visible as white stripes shining through its red to purple-black fruit (Petoe et al. 2018), whereas the vascular bundles of *H. moluccana* are smaller and closely

spaced (Essig 1982). The fruit color of *Hydriastele moluccana* is unknown (Essig 1982, Petoe et al. 2018), but partially disintegrated fallen fruit that we were able to obtain suggest that ripe fruit may be yellow with a red layer underneath (Fig. 9).



10. *Areca vestiaria*. Habit. Photo: B.G. Kuhnhäuser.



11 (top). *Areca vestiaria*. Inflorescence at anthesis and immature infructescence. 12 (bottom). *Areca vestiaria*. Young infructescence. Photos: B.G. Kuhnhäuser.

The most common palm on Gunung Gamalama was *Areca vestiaria* Giseke, a single-stemmed palm of 2–8 m height that dominated the undergrowth throughout most

of the forest, with many individuals bearing both flowers and fruits (Figs. 10 & 11). It was easily distinguishable from all other palms on the mountain by being the only palm in the



13 (top). *Areca vestiaria*. Immature infructescence. Photo: B.G. Kuhnhäuser. 14 (bottom). *Areca vestiaria*. Mature infructescence. Photo: S. Suparman.

lower understorey, having stilt roots, and broad leaflets spreading out in a plane. It has a slightly bulging crownshaft that is green to yellow. The main axis of the inflorescence

ascends at an angle of ca. 45 degrees and bears light yellow flowers (Fig. 11). The inflorescence axes are initially yellow and turn red as the fruits develop (Figs. 11–14). The fruits are



15. *Rhopaloblaste ceramica*. Habit. Photo: B.G. Kuhnhäuser.



16. The summit of Gunung Gamalama. Photo: B.G. Kuhnhäuser.

initially yellow (Fig. 12), turn green during fruit growth to form a striking contrast with the red inflorescence axes (Fig. 13), and are finally bright red at maturity (Fig. 14). As typical for the genus, the tips of the infructescences are brown and shrivelled (Figs. 12–14).

Areca vestiaria occurs widely across Sulawesi and Maluku and was mentioned by Beccari as highly abundant on Gunung Gamalama (Beccari 1877). Interestingly, the species is reported to usually have an orange to red crownshaft (Heatubun et al. 2012), whereas the individuals we observed had green to yellow crownshafts (Figs. 10 & 11). Reports of *Areca vestiaria* from Sulawesi highlight its bright orange or red crownshaft, whereas the color of the crownshaft was not mentioned in reports of the species from the island of Buru in Maluku, indicating that the crownshafts of populations on Buru may not have a distinctive coloration (Dransfield 1974). It thus appears that the orange to red coloration of the crownshaft may only occur in populations on Sulawesi, whereas it is green to yellow in Maluku.

The final species we encountered was *Rhopaloblaste ceramica* (Miq.) Burret, an elegant tree palm of ca. 10–15 m height that just emerged above the canopy (Fig. 15). Although we did not encounter flowering individuals,

the species was easily distinguished from other palms by its slender, very straight trunk, straight crownshaft, and horizontally oriented leaves with sparsely placed, short narrow leaflets, giving it an airy appearance. The crownshaft was dark green in the lower three quarters but light brown in the uppermost quarter just below the petiole. We saw the species only as scattered individuals in the lower parts of the montane rainforest between ca. 900 and 1000 m, slightly above the recorded upper altitudinal limit of 900 m of the species (Banka & Baker 2004, Baker et al. 2024). *Rhopaloblaste ceramica* is the only species of the genus known from Maluku, and to our knowledge, our observation is the first record from Ternate (Banka & Baker 2004).

Above ca. 1400 m, the palms disappeared and the understorey became dominated by tree ferns. Ascending further, the forest changed at about 1500 m into a mono-dominant grassland more than 2 m tall, which gave way to bare volcanic soil at approximately 1600 m (Fig. 16). Here, we unexpectedly encountered a final palm: *Areca catechu*, this time as fruit offerings on a grave marked by stones (Figs. 17 & 18).

Discussion

During our fieldwork in Ternate, we recorded a total of nine palms, including two



17 (top). Grave on the summit of Gunung Gamalama marked by stones. 18 (bottom). Offerings next to the grave: fruits of *Areca catechu*, pepper, lime and cigarettes. Photos: B.G. Kuhnhäuser.

widespread native species in the lowlands (*Metroxylon sagu*, *Nypa fruticans*), three cultivated species (*Cocos nucifera*, *Arenga pinnata*, *Areca catechu*), and four less well-known native species in the montane rainforest on Gunung Gamalama (*Heterospathe glauca*, *Hydriastele moluccana*, *Areca vestiaria*, *Rhopaloblaste ceramica*). Interestingly, the four

palms that we encountered on the volcano all belong to tribe Areceae and are restricted to eastern Malesia, some occurring only on Maluku (*Heterospathe glauca* and *Hydriastele moluccana*) while others are more widespread across Sulawesi and Maluku (*Areca vestiaria*) or Maluku and New Guinea (*Rhopaloblaste ceramica*). Even though the search for rattans

had prompted our exploration of Gunung Gamalama, we did not encounter a single rattan palm on Ternate during our fieldwork.

In addition to our observations, six further native palms have previously been recorded from Ternate. These include *Caryota rumphiana* Mart. (collected by Beccari in 1874), the type of *Pinanga ternatensis* Scheff. (synonym to *Pinanga rumphiana* (Mart.) J.Dransf. & Govaerts) and three species of the rattan genus *Calamus*, namely *C. heteracanthopsis* A.J.Hend. (collection *Beguín 771*, BO), a sterile specimen of *C. vitiensis* (collection *Roea 1662*, BO) and *C. piscarpus* Blume (Miquel 1855), which is a name of uncertain application (Henderson 2020) but may be related to *C. aruensis* Becc. (Beccari 1908). Finally, Beccari cautiously mentioned that *Drymophloeus oliviformis* (Giseke) Mart. had been recorded by others from Ternate (Beccari 1877). Taken together, 15 palm species have been recorded from Ternate, including three cultivated species.

It is somewhat surprising that we did not encounter any of the six species previously observed by others, especially *Caryota rumphiana* and *Pinanga rumphiana*, which are widespread and commonly found even in disturbed vegetation in New Guinea (Baker et al. 2024). This may be explained by the almost complete loss of primary forest below 900 m above sea level. Over-exploitation of useful palms may have further contributed to the disappearance of some species, especially the rattan palms. Given that our field work was limited to relatively easily accessible localities along the coastal road and the summit trail on Gunung Gamalama, it is also possible that we simply did not explore the right vegetation to encounter these palms.

Further field work is necessary to ascertain the fate of the six “missing” palms of Ternate. During our explorations, we did not manage to localise or enter undisturbed forest between sea level and 900 m, an altitudinal range that has almost completely been converted to plantations but is highly suitable for a multitude of palms that neither occur in coastal nor montane habitats. However, satellite-based analysis of land use indicates that forest extends in some places on the western and northern slopes of Gunung Gamalama from the protected area at 900 m down to approximately 100–400 m (Sarihi et al. 2020). Indeed, there are several locations below 900 m that are difficult to access, such as steep slopes and ravines (Abdulrasyid

Tolangara, pers. comm. 2024). These locations have likely experienced limited disturbance by humans and may thus still retain largely intact forest vegetation, including palms.

In addition, some palms may still persist in secondary forest near easily accessible locations on the lower slopes of Gunung Gamalama, such as Moya village (Taman Love), the tomb of Sultan Babullah, or Air Tege-Tege. For example, *Hydriastele moluccana* has previously been collected in the 1920s in the lowlands of southern Ternate at North Laguna (collection *Beguín 774* [BO]). We therefore have reason to be optimistic that further field work may be rewarded by the discovery or re-discovery of several more palm species.

Acknowledgments

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Suspected Lesion Mimic Mutants in Mule Palms (×*Butyagrus nabonnandii*)

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We report the occurrence of spontaneous lesion formation known as “lesion mimic mutants” in mule palms, an artificial hybrid between pindo (*Butia capitata*) and queen (*Syagrus romanzoffiana*) palms. Sunlight is a trigger for lesion development in symptomatic mule palms, that eventually wither off and die. Hybridization may create novel genetic combinations that lead to lesion mimic mutants. We propose the need for additional surveys to determine the frequency of lesion mimic mutants in palms.

In summer 2021, one of the authors (BD) visited a 500-acre palm nursery in south Florida, where the palm grower expressed concern about potential health issues with mule palms (×*Butyagrus nabonnandii*). Leaf spots were observed on multiple fronds that gave the mule palms an overall yellowish appearance. These palms showed a decline in vigor as compared to adjacent healthy mule palms that had dark green fronds. The grower

recorded a high cull rate of more than 20% as the symptomatic mule palms would eventually wither off and die. The decline in health and subsequent mortality was restricted only to mule palms. Over the course of next ten months, four additional farms were visited in central and south Florida with a cumulative area of over 1,300 acres, and similar decline and mortality issues were observed in mule palms, whereas no other palm species with similar symptoms were seen at these sites. No apparent spatial pattern was evident for the declining mule palms in the field. Both container- and field-grown mule palms had been treated with multiple fungicide and fertilizer applications without any improvement in the palm health suggesting that neither disease nor nutritional deficiency was responsible for causing mule palm decline. Based on their years of experience in growing

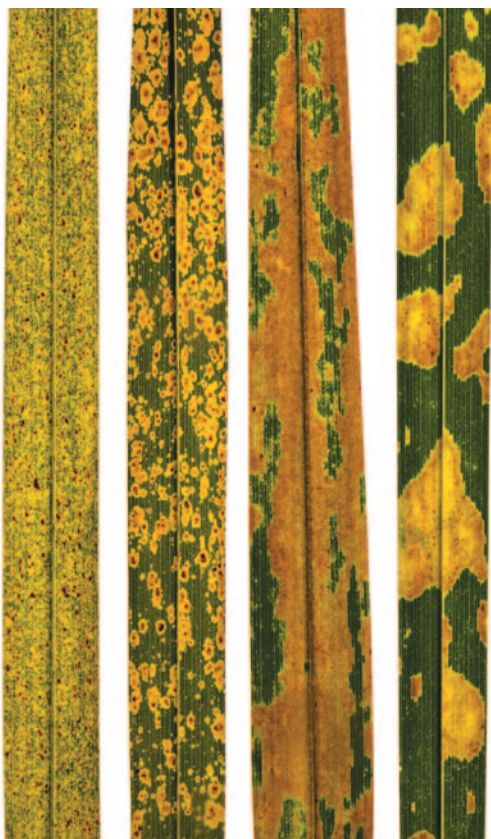
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1. Lesion mimic mutant (LMM) mule palms exhibit variation in lesion size and density. Four leaflets collected from different LMM mule palms displayed lesions of various shapes and sizes including (left to right), 1) small, chlorotic and necrotic lesions, 2) lesions with necrotic center with chlorotic halo, 3) lesions that have merged to cover most of the leaflet and 4) lesions that appear as splotches.

mule palms, a consensus among growers was that the mule palms that started out as healthy seldom showed any symptoms, but the symptomatic mule palms never reverted to good health.

The symptom development seen on diseased or nutrient deficient plants is usually very consistent and characteristic of a particular pathogen or element imbalance, respectively. In the majority of cases, the symptomology is very dependable such that the disease or nutrient deficiency can be easily diagnosed based on the distinctive symptoms. However, in this case, the leaf spots or lesions on mule palms fronds were not consistent but varied by color, size, density and growth type across the different individuals (Fig. 1). This lack of uniform symptoms alludes to the absence of a pathogen as the underlying cause for the leaf spots. Moreover, the distribution of lesions

across the fronds on a given individual was also non-uniform. Lesions were non-existent on the newly emerging fronds and lesion density increased as the fronds matured. Even though the older fronds were full of lesions, they did not seem to spread or affect adjacent healthy mule palms or palms of other species ruling out a pathogen as the causal agent.

Nutritional deficiency could be ruled out as the cause, as similar health decline symptoms were observed and comparable mortality rates were reported for mule palms growing across different regions, soils and environmental conditions. The majority of nutritional issues can be resolved by application of fertilizers and are rarely lethal. Even though the different palm species were subjected to a similar fertilizing regimen, mortality was still observed in mule palms. As the lesions on mule palms did not appear suddenly but rather progressed with frond maturity, it suggested that neither phytotoxic compounds nor other abiotic factors may be responsible for the lesions.

The appearance and development of leaf spots or lesions as fronds mature could be explained by a unique phenomenon, known as “lesion mimic mutant.” The term “lesion mimic mutant” (LMM) implies that disease-like symptoms such as chlorotic and necrotic lesions can spontaneously form even in the absence of a pathogen, making a disease-free plant to appear like a diseased plant. The prevalence of LMMs in hybrid plants was first discovered 100 years ago in hawkbeard (*Crepis*) plants (Li & Weigel 2021) and has since been reported in several crops including maize, rice, barley, wheat, soybean, tomato, brassica, cotton, pepper, tobacco and potato (Bruggeman et al 2015, Freh et al 2022). The observations made in mule palms were similar to what has been described in LMM plants. In LMM mule palms, the appearance of lesions seemed to be developmentally regulated. A newly emerged frond did not show any lesions. On younger fronds, lesions started out as small, water-soaked flecks and as the fronds matured, the lesions increased in number as well as size (Figs. 2 & 3). Intra- or inter-specific crosses in crops like corn, wheat and rice, resulted in lesions that advance with leaf maturity leading to premature death of leaves and whole plants in a fraction of hybrids (Li & Weigel 2021). Similarly, mule palms result from an inter-generic cross where a subset of palms exhibit chlorotic and necrotic lesions as fronds mature, leading to frond death and eventually the whole palm dies.



2. Lesion mimic mutant (LMM) mule palm showing developmental progression of lesion development. The leaflets on the lower fronds are either completely necrotic or filled with chlorotic and necrotic leaf spots. The leaflets on younger fronds are green and healthy.

Lesion development in LMMs can be influenced by the genetic makeup of the plant and environmental factors, such as temperature and sunlight (Johal et al 1995). In plants, like corn and *Arabidopsis*, it was

demonstrated that controlled crosses of LMM plants with different cultivars or inbred lines, can either enhance or turn off lesion formation, highlighting the importance of genetic makeup in regulating the LMM



3. Close-up of the fronds on a lesion mimic mutant (LMM) mule palm. The bottom half of the image has older fronds showing splotches on the leaflets. The upper half of the image shows younger fronds with green leaflets.

phenotype (Hoisington et al 1982). A comparable trend was found in symptomatic mule palms where lesions across multiple individuals presented in different sizes and shapes (Fig. 1).

To estimate the number of mule palms exhibiting the lesion development pattern characteristic of LMMs, we surveyed a population of approximately 450 container-grown mule palms. We found that the LMM

Table 1. Distribution of lesion mimic mutants (LMMs) in a plot of container-grown three-year-old mule palms. *Lesion mimic mutants (LMMs).

Rows	Healthy	LMMs*	Total	% LMMs
1, 2	55	14	69	20.3
3, 4	46	20	66	30.3
5, 6	43	22	65	33.8
7, 8	42	20	62	32.3
9, 10	42	18	60	30.0
11, 12	40	19	59	32.2
13, 14	40	17	57	29.8
15	22	6	28	21.4
Total	330	136	466	29.2

phenotype was present in 29% of the three-year-old mule palms growing in 15-gallon pots in full sun (Table 1). This observation matches the high cull rate for field-grown mature palms that the growers have reported.

In order to confirm the LMM phenotype, leaflets on symptomatic mule palms were covered with aluminum foil, to prevent sunlight from reaching that section of the leaflet and maintain complete darkness. As sunlight is one of the triggers for lesion formation in LMMs, the expectation was that lesions will fail to develop in the leaflet section covered with the foil. Briefly, ten field-grown symptomatic mule palms were selected randomly and a 5-inch-wide piece of aluminum foil was wrapped around the base of a leaflet on the youngest fully open frond free of any lesions (Fig. 4). Only one leaflet per mule palm was covered, i.e. a total of 10 leaflets were examined. The four edges of the wrapped foil were crimped to ensure that the foil did not slide out. This experiment was started in March 2022 and the aluminum foil was removed after a period of 3 months. We

found that the covered part of the leaflet was free of lesions even though it was adjacent to the section with leaf spots (Fig. 5). This observation that leaf spots failed to develop on a section of the leaflet that was wrapped with the foil and kept in the dark confirmed that these mule palms were LMMs.

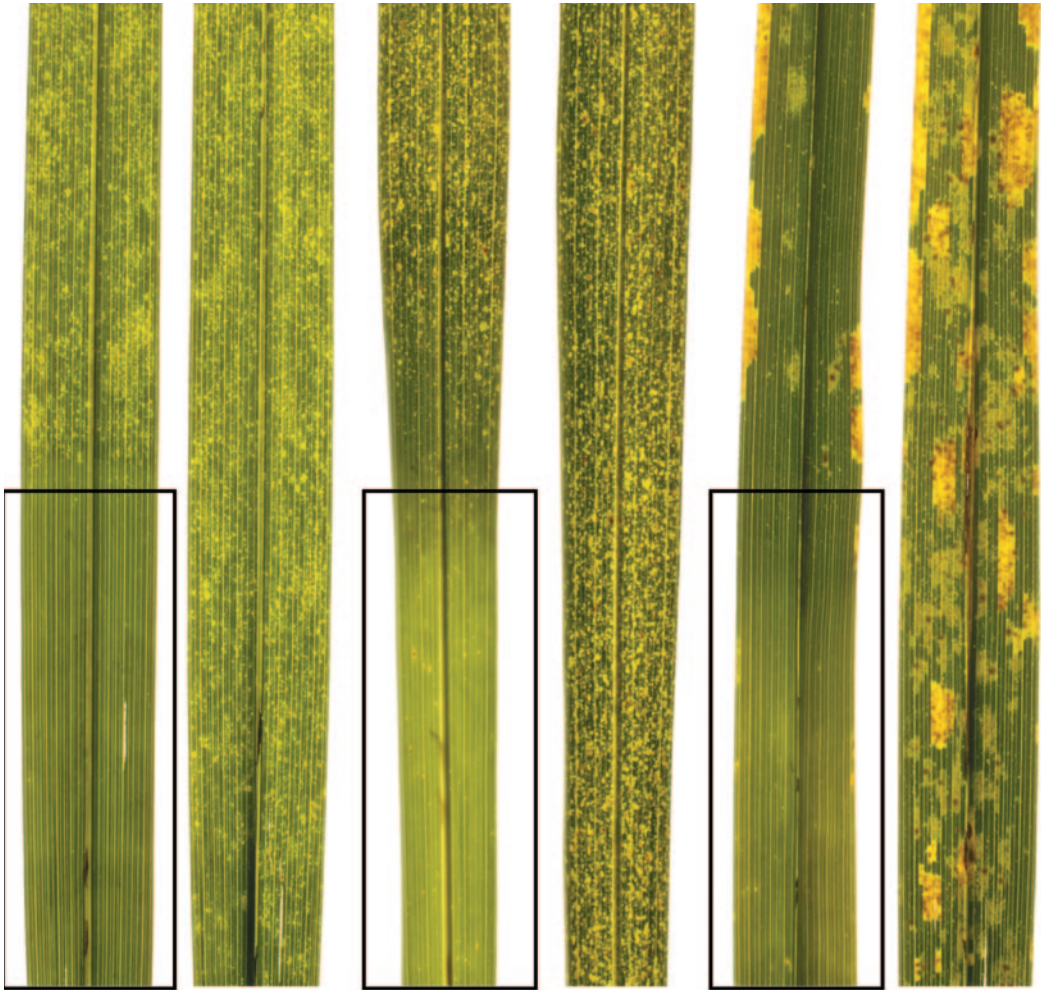
The lesions observed in LMM mule palms can be compared to an ‘autoimmune disorder’. The highly regulated and tightly controlled plant immune system is geared to detect and defend against pathogen attack. However, ill-timed functioning of the immune system comes with fitness costs, i.e., autoimmunity. In autoimmunity, the host fails to differentiate self from non-self and starts to attack itself leading to symptoms like leaf chlorosis and necrosis, stunted growth, followed by plant death (Freh et al 2022). Hybridization was determined to be the dominant cause for autoimmunity or hybrid necrosis (Würschum et al 2023). The Bateson-Dobzhansky-Muller model posits that hybrid necrosis may result from detrimental interactions between genetic loci that come from vigorous and fertile parents (Orr 1996).



4. Aluminum foil wrap method to detect lesion mimic mutant (LMM) mule palms. A green leaflet on a young frond lacking leaf spots was wrapped in aluminum foil to exclude sunlight. The four corners were folded so that the foil stays snug and doesn't loosen up.

Hybridization can generate novel genetic combinations that may disrupt cellular homeostasis leading to cell death in lesion mimic mutants (Li and Weigel 2021) and as cells die, lesions start to develop in LMM mule palms.

Mule palm ($\times$ *Butyagrus nabonnandii*) is an intergeneric hybrid generated from a cross between pindo palm (*Butia capitata*) and queen palm (*Syagrus romanzoffiana*), both belonging to tribe Cocoseae, subtribe Butiinae. This cross was first attempted by Paul Nabonnand, a



5. Exposure to sunlight triggers formation of leaf spots in lesion mimic mutant (LMM) mule palms. In each pair, one leaflet (on the left) was partly covered with aluminum foil while the other leaflet (on the right) was completely exposed to light. The bottom covered section was in the dark and did not develop lesion mimic phenotype, but the section exposed to sunlight shows lesion development. The black box marks the section that was covered.

French nurseryman, around 1890s (Tournay 2009) and then rediscovered almost a 100 years later in the US (Wilcox et al 1990). There are 2,600 species (Baker & Dransfield 2016) and 114 natural hybrids (Henderson 2022) known in palms, but to our knowledge this is the first documentation of occurrence of LMMs in palms. So, a targeted survey to determine the occurrence and frequency of LMMs in different palm hybrids is needed.

The appearance of lesions is usually symptomatic of a risk to plant health. Correct identification of the agent responsible for the lesions ensures that appropriate management options are utilized to restore health of the plant. When lesions are caused by external agents such as pathogens or nutrients, palms

can be treated with either fungicides or nutrients to remedy the issue, but this does not hold true for LMMs. As the lesions observed in LMMs arise due to genetic anomalies, no external inputs can be applied to correct the lesions. Repeated applications of fungicides and fertilizers have not proven effective in improving the health of LMM mule palms. This underscores the need for a proper diagnosis of the agent causing the lesions and avoid unnecessary fungicide or fertilizer treatments thereby reducing input costs.

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Creating a Conservation Collection of *Pritchardia woodii*, Endemic to East Maui

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LEROY KRAUSE¹ AND HANK OPPENHEIMER³

As part of the 2022 Save the Species campaign, the International Palm Society sponsored the National Tropical Botanical Garden to conduct field work to develop ex situ representation of the Critically Endangered species, *Pritchardia woodii*.

The Hawaiian Islands possess one of the highest levels of endemism of any floristic region on the planet, 90% of its 1,367 native vascular plants being endemic (Rønsted et al. 2022). Many species in Hawai'i, such as *Pritchardia woodii* Hodel (Fig. 1), are threatened largely due to their restricted distribution. The natural range of *P. woodii* extends from Waiho'i and Kīpahulu valleys on the East-Southeast side of the island of Maui along the dormant

Haleakalā volcano. The trees are remote, only accessible via helicopter with required permits.

The genus *Pritchardia*

Pritchardia Seem. & H.Wendl. are erect, solitary-stemmed, medium-sized, unarmed, pleio-nanthic palms up to 30m (sometimes up to 40m) tall (Fig. 2) (Wagner et al. 1999). Commonly referred to as Hawaiian fan palms or *loulou*, these charismatic members of the forest are easily recognizable, as their fronds emerge beyond the surrounding canopy (Figs. 3 & 4), providing an incredible contrast to the dynamic landscapes in which they are positioned. Leaves (Fig. 5) form a skirt around the canopy of the tree and are self-cleaning as they drop from the trunk. Trunks generally remain smooth, but are often left with faint remnants of leaf scars. In the wet forest habitat of some of these *Pritchardia*, it is not unusual for epiphytic ferns, mosses and even small trees to anchor themselves to the palm trunks or canopies. Emerging from among the leaves and enclosed in numerous tan, tubular,

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1. Fragmented colony of *Pritchardia woodii* palms typical in the upper Waiho'i Valley. Photo: Mike Oppenorth.

overlapping and sheathing modified leaves (bracts), the inflorescences ascend, but then may droop or hang down when heavily laden with fruit (Fig. 6) (Hodel, 2007). Fruit size varies amongst the different species of *Pritchardia*, but, generally, the fruits emerge green and grow in size until they are dark brown to black when mature or ripe (Fig. 7). The densely arranged flowers can be quite fragrant when open and ready for pollination, laden with nectar. Many small and large native pollinators visit these plants in habitat, whereas in cultivated or disturbed areas other introduced pollinators such as ants (Formicidae), european honeybees (*Apis mellifera*) and earwigs (*Dermaptera* sp.) are common. The extent and health of natural stands of *Pritchardia*, along with Hawaiian native ecosystems as a whole, have been declining since the arrival of humans to the archipelago.

The decline of Hawaiian palms begins with the introduction of the Polynesian rat (*Rattus exulans*) brought by traveling Polynesians, which prey upon the fruits of the palms. This negative trend was exacerbated by western influence, as the introduction of mosquitoes (~1826 AD) by visiting European ships further

contributed to the dramatic decline of Hawaiian native honeycreepers, a documented disperser of fruits. For example, a now extinct honeycreeper species known as 'ula-'ai-hāwane (*Ciridops anna*) or the "red bird that eats hāwane," hāwane being the general name of Hawaiian *Pritchardia* fruit. As natural fruit dispersers like 'ula-'ai-hāwane have gone extinct, the ability for Hawaiian *Pritchardia* to naturally disperse between islands and valleys, became disrupted. The cumulative effect of these impacts has resulted in fragmented and genetically restricted, wild populations (Chapin et al. 2004).

Unfortunately, the condition of these palms and their surrounding forest is expected to continue their decline. Further, in 2013, a new pest to Hawai'i known as the Coconut Rhinoceros Beetle (CRB; *Oryctes rhinoceros*) was discovered on O'ahu and has recently been observed damaging wild specimens of Hawaiian *Pritchardia* on that island. At the time of this writing, CRB has also become established on the island of Kaua'i. On Hawai'i and Maui, isolated outbreaks have been identified and contained, but this pest will continue to be a significant statewide threat



2. Mature loulu (*P. woodii*) in habitat. Photo: Mike Opgenorth.

for the foreseeable future. If not controlled, CRB has the potential to eliminate all of Hawaii's native *Pritchardia*, alongside hundreds of other cultivated palm species in the islands. The need to bolster conservation efforts for Hawaiian *Pritchardia* and other palms in Hawai'i is more important than ever.

The genus *Pritchardia* is monophyletic and sister to *Copernicia*, however, definitive genetic relationships among *Copernicia*, *Pritchardia* and *Washingtonia* are reported to be uncertain due to gene-tree incongruence (Bacon et al. 2012b). The complex genus of approximately 29 species (POWO 2024) are restricted to tropical



3 (top). Aerial view above a colony of *P. woodii* associated with diverse native forest. Photo: Zach Pezzillo. 4 (bottom). Traversing through head high ferns and other shrubs in the vicinity of *P. woodii*. Photo: Mike Opgenorth.

Pacific Islands (Fiji, Samoa, Tonga and Tuamotus). Adaptive radiation from one single colonization event to Hawai'i from the central	Pacific is inferred from a dispersal event followed by local extinction (Bacon et al. 2012b).
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5. Underside leaf habit of *P. woodii*. Photo: Mike Opgenorth.

Pritchardia woodii

There are currently 24 recognized taxa of Hawaiian *Pritchardia* (POWO, 2024), most have legal, endangered status and are in immediate need of ex situ conservation (Chapin et al. 2004). *P. woodii* is one of only two *Pritchardia*

species that were not analyzed under the most recent published population genetic study and species delineation by Bacon et. al (2012a). Therefore, it remains to be tested as to how *P. woodii* relates to other *Pritchardia* species or how genetics vary between remaining subpopulations. Derral Herbst was the first to



6. *P. woodii* fruit. Photo: Hank Oppenheimer.

describe the existence of *P. woodii* during a botanical survey of Waiho'i valley in 1972 (Hodel 2012). Prior to this project, only two registered ex situ plants existed on O'ahu at Ho'omaluhia and Wahiawa Botanical Gardens representing collections by R. Read and R. Hobdy in 1987 from Waiho'i valley and one at Wahiawa Botanical Garden representing those first collections by D. Herbst in 1972.

The National Tropical Botanical Garden (NTBG) in Hawai'i, with perhaps the most robust *Pritchardia* collection in the globe, has yet to establish this East Maui palm to their collections. *Pritchardia woodii* is named in honor of Ken Wood, field botanist for NTBG on Kaua'i and prodigious collector of Hawaiian *Pritchardia*, including two of the paratypes of this species (Hodel 2007). They occur naturally on the East-Southeast slopes of Haleakalā on the island of Maui (Fig. 8) from 2,600 feet to 3,700 feet (792–1,128 m) between two subpopulations. The palms are primarily found in Waiho'i valley, with a few individual plants in Kīpahulu valley under the management of Haleakalā National Park. The palm grows up to 15 m tall in mesic to wet forests (Fig. 9) associated with *Cheirodendron trigynum* subsp. *trigynum*, *Cibotium glauca*, *Cibotium menziesii*,

Clermontia arborescens subsp. *waihiaae*, *Clermontia kakeana*, *Dicranopteris linearis*, *Diplopterygium pinnatum*, *Ilex anomala*, *Isachne distichophylla*, *Machaerina angustifolia*, *Machaerina mariscoides* subsp. *meyenii*, *Melicope clusiifolia*, *Metrosideros polymorpha*, *Myrsine sandwicensis*, *Myrsine lessertiana*, *Sadleria pallida* and *Sadleria souleyetiana*. Many other rare native species dwell in the vicinity. *Pritchardia woodii* is similar to the other East Maui endemic palm species, *Pritchardia arecina*. However, *P. woodii* differs in having leaf blades completely covered abaxially with lepidia and petioles with an abundance of fibers proximally (Hodel, 2007).

Fieldwork

An assessment of the distribution range of *P. woodii* was required in order to guide the subsequent strategy for careful and efficient collections. We conducted an aerial survey in 2021 to first identify how many *P. woodii* are in Waiho'i valley, which confirmed a total of approximately 414 plants scattered throughout

7. Individual fruit (upper photo) and husked seed (lower photo). Photos: Mike Oppenorth.





8. Remaining clusters of *P. woodii* are fragmented, usually composed of a handful of trees. Photo: Mike Opgenorth.

the upper reaches of the valley. This trip also allowed us to make the initial collection of 3 seeds from the lowest elevation trees at just over 2,500 feet elevation at the base of the valley below Pu'u Ho'olio (Fig. 10). Based on these findings, we then developed a map in order to outline the various stands of *P. woodii* remaining throughout the valley. This map identified areas where collections could take place in subsequent trips as we aim to capture a wide range of maternal lines from different corners of the valley.

Utilizing this data from the aerial survey, we developed the first IUCN Red List assessment for *P. woodii* (Opgenorth and Nyberg, 2021) and after evaluation of data that was collected the species was classified as Critically Endangered through IUCN Criteria B1ab. The remaining Extent of occurrence (EOO), found

to be less than 100 square kilometers, occurs in one location (Maui), is severely fragmented and is experiencing a continued decline in the extent of occurrence, reduction in quality of habitat and number of mature individuals (<500 mature individuals).

Upon completing the description of the remaining range of *P. woodii* and, having obtained financial support for additional field work from the International Palm Society, the team returned to Waiho'i in search of viable fruit. Weather conditions fluctuate significantly in Waiho'i valley, which can frequently become enveloped in dense clouds accompanied by chilly rain showers, hence its name, which means the "returning water." This valley is difficult to traverse and is a place of legend, not casually visited. Kahuoi, an ancient, revered Hawaiian farmer is one such

kupuna (ancestor) of this valley known for establishing an 'Iholena'-type banana patch so large, that markers were required so that people could navigate around it (Fornander, 1917). Given the proximity of this banana patch to remaining *P. woodii*, there is no doubt that Kahuoi knew of, and likely utilized, the beautiful loulu of Waiho'i.

Each trip into Waiho'i presented the opportunity to collect from different trees (Back Cover), but also revealed the threats these trees face. As the team approached the palms, we were surprised to see rats jumping out from the canopy, confirming our fears as we discovered evidence of rat-predated fruits on the forest floor (Fig. 11). Thankfully, part of the valley is fenced off to reduce damage from non-native pigs, though it is likely that axis deer (*Axis axis*) are already in the general vicinity and able to leap above existing pig fences. Even with these challenges to find ripe fruits, we were able to find some different inflorescences in the valley. Fruits and vouchers were collected from *P. woodii* during two separate trips and were transferred to NTBG at its Kahanu Garden and Preserve location in Hāna, Maui. After initial cleaning,

organizing of samples and uploading of collection data into the NTBG Living Collections Database, a portion of the fruits were promptly (<1 week) sent to Lyon Arboretum in Mānoa, O'ahu. Seeds that germinated were documented and tagged according to their maternal parent.

Embryo rescue

The removal of developing embryos is useful when genetic or environmental factors prevent the development of fully-formed, functional fruits. Meanwhile, it has been reported that embryo culture has been extremely successful in the rescue of immature embryos from the genus *Pritchardia* (Suggii 2010). As many of the fruits in Waiho'i were still green due to rat predation on ripe fruits, Lyon Arboretum staff enacted modified protocols originally developed by Sugii (2010) to conduct embryo rescue where standard greenhouse propagation may not result in viable seedlings (Fig. 12). The exterior of the fruits was sterilized with Dawn dish soap. Cleaned whole fruits were placed in 10% Clorox (Clorox NaOCl initial concentration = 7.25%) for 20 minutes with 1 drop of tween 20 per 100 ml solution. In a laminar flow hood, *Pritchardia* fruits were

9. Inflorescence emerging from the crown of *P. woodii*. Photo: Mike Oppenorth.





10. Unobstructed view from the Hāna coast looking toward Waiho'i valley and Pu'u Ho'olilo (center) on a rare clear day. Photo: Mike Opgenorth.

rinsed with clean water. Fruits were cut open under aseptic conditions with sterilized pruning shears, taking care not to touch the embryo with hands or any unsterilized tools. Embryos were then placed into test tubes with $\frac{1}{2}$ MS medium after 1 week. These modified methods allow for the removal of sterile embryos without exposing them directly to sterilizing solution, increasing their survival and lowering contamination rate compared to previously used methods. Cultures were grown under 14/10 h (day/night) light, with a light intensity of $55 \mu\text{mol m}^{-2}\text{s}^{-1}$ at culture vessel level. Culture room temperature ranged from 22°C to 23°C .

Cryopreservation

It has been suggested that further research is needed to establish reliable protocols for storage of *Pritchardia* palm seeds (Pritchard et al. 1998). In an effort to extend storage of *P. woodii*, a portion of fruits (20) collected on 10/1/2023 in Waiho'i valley underwent cryopreservation protocols at the University of Hawai'i Harold Lyon Arboretum. Excised embryos using the methods above were placed on sterile filter paper in an open sterile glass

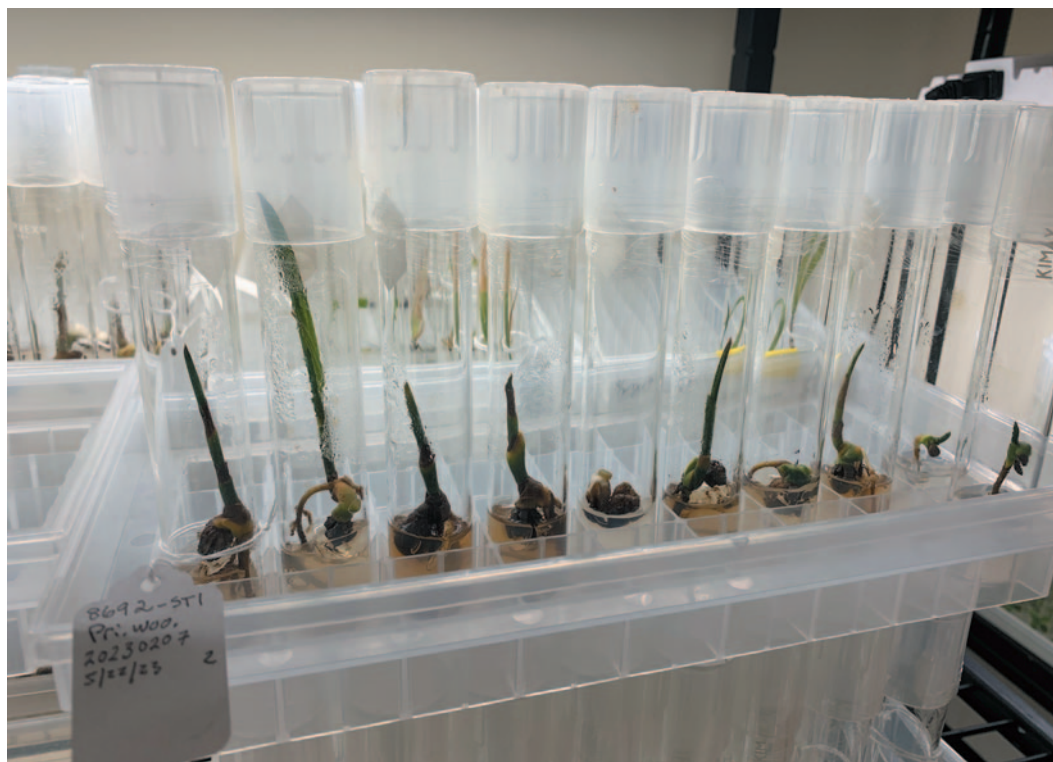
petri dish under laminar airflow. Embryos were then exposed to the airflow for 4.5 hours, which has been reported in other *Pritchardia* species as sufficient time to obtain approx. 20% water content reaching a water content of 33.4% ($0.334 \text{ g H}_2\text{O/g}$ fresh weight or $0.502 \text{ g H}_2\text{O/g}$ dry weight). Water content was calculated by taking a small subset of the embryos after drying in the laminar airflow, weighing them (fresh weight), then fully drying them in a drying oven overnight at 105°C . Water content was also calculated for untreated embryos using the same methods. Embryos dried in the laminar airflow were placed in a foil packet and placed into liquid nitrogen storage. After recovering from liquid nitrogen, embryos were thawed in a 40°C water bath for 10 minutes and inspected for viability.

Propagation at Kahanu Garden

At NTBG Kahanu Garden, seeds were sown in 1:1 mix of Promix HP and small black cinders. Trays of up to 25 fruits per tray were placed inside a covered corrugated plastic greenhouse. Irrigation was delivered twice daily by overhead sprinklers, fed by rain water. The



11. Leroy Krause displays rat-predated seeds, typical of all clumps of trees that were visited. Photo: Mike Oppenorth.



12. Young *P. woodii* grown from embryo rescue protocols at Lyon Arboretum.

Kahanu Garden nursery is located approximately 75 ft. elevation above mean sea level (Fig. 13). Germination behavior aligned closely with other Hawaiian *Pritchardia* species, with viable fruits emerging within 2 or 3 months.

Results

Seeds were collected from 12 different *P. woodii* trees in Waiho'i Valley, each with varying ripeness of fruits. Again, due to rat predation and remoteness of the trees, we needed to collect what was available during days of good weather. Ripeness of fruit harvested ranged from mature green, to fully ripe. Two of the 12 trees did not yield any germinated seedlings. All together, 126 fruits of varying ripeness and condition were sown at Kahanu Garden with 19 (15%) reaching germination. Lyon Arboretum received 72 total fruits from which 48 (67%) viable embryos were sown. Approximately 25 (52%) of these embryos germinated and formed plants healthy enough to transfer to Kahanu Garden or Lyon Arboretum living collections. Four young plantlets were also transferred from Olinda Rare Plant Facility to Kahanu Garden from the Plant Extinction Prevention Program's (PEPP) previous efforts to collect and propagate *P. woodii*.

Cryopreservation attempts aimed to bring the embryos closer to 20% water content, but it is difficult to estimate the water content until after the procedure is complete. It has been observed that 4.5 hours would be enough time to get to about 20% water content for other *Pritchardia* species/maturity levels. Unfortunately, none of the embryos exposed to cryopreservation protocols survived liquid nitrogen exposure.

A summary of the results can be found in Table 1 and Table 2. A total of 48 living seedlings from this project is growing at the time of this report. Over one-third of the fruits (34%) transferred to Lyon for embryo rescue germinated successfully, though it is unclear how many of the immature fruits will have weakened resilience or structural deficiencies as they grow larger. When accounting for the fruits removed after initial screening, 52% of high quality embryos germinated. Fruits sown at the Kahanu Garden greenhouse with and without the outer husk showed no difference in germination success.

Discussion

Hawaiian *Pritchardia* species are at increased risk of extinction in the wild and require

conservation action to ensure that the genetic diversity of remaining subpopulations is preserved. Thanks to their ornamental value, many palm enthusiasts have assisted conservation of *Pritchardia* species by placing them in their collections. However, care should be taken through partnership with private and commercial horticulturalists to monitor genetic drift, hybridization and potential inbreeding. One way to do this is by having palm growers document provenance data for the plants in their collection and seek out the origin story of plants they acquire. Once plants are removed from the wild and/or conservation facilities, it becomes increasingly difficult to track provenance data, which is important in case notable phenotypes, such as disease resistance, are found within particular trees.

In addition, it is expected *P. woodii* may qualify to be federally listed within the U.S. Endangered Species Act which would restrict future collection from the wild and cultivation without a permit. It has also been suggested that *Pritchardia* can hybridize, therefore raising the need for care when propagating from cultivated trees, which may have cross-

pollinated with other *Pritchardia* species in the vicinity. We recommend a future study to develop protocols for successful hand pollination of Hawaiian *Pritchardia* that will help those with appropriate access to plants to ensure that progeny are of the intended genetic stock and prevent the unintentional development of hybrid fruits, particularly if they are collected for eventual reintroduction into the wild.

The success of embryo rescue as part of this project represents a significant improvement over standard greenhouse propagation. While it remains to be seen how many of the immature fruits germinated by embryo rescue are viable in the long term, future projects with limited access to remote and extraordinary trees should consider embryo rescue as a viable alternative to conventional seed germination when ripe fruit are rare or difficult to come by.

Water content levels in embryos are important for the success of cryopreservation. How fast *Pritchardia* fruits dry via laminar airflow seems to depend on the maturity of the fruit and possibly also the species. Further efforts to conduct cryopreservation of *Pritchardia* should

13. *P. woodii* almost ready for planting out at Kahanu Garden, Hāna, Maui.



Loulou <i>Pritchardia woodii</i> total collection and germination data						
NTBG Accession	Elevation (m)	Fruits	Material	# Living Seedlings	% Germinated Kahanu	Location Germinated
20210297	802	3	3 fruits	2	67%	Kahanu
20230012	1097	–	seedlings (4)	4	–	Olinda RPF
20230207	1097	52	42 fruits to NTBG Kahanu; 10 to Lyon	5		Kahanu/Lyon
20230206	1097	4	4 fruits	0	0	Kahanu
20230205	1097	15	15 fruits to NTBG Kahanu	1	7%	Kahanu
20230204	1097	15	15 fruits to NTBG Kahanu	0	0%	Kahanu
20230203	1097	5	5 fruits to NTBG Kahanu	0	0%	Kahanu
20230538	975	6	2 fruits to NTBG Kahanu; 4 fruits to Lyon	2 Lyon	100%	Kahanu/Lyon
20230537	970	58	20 fruits to NTBG Kahanu; 38 fruits to Lyon	7 Kahanu Garden (KG) 12 Lyon	35%	Kahanu/Lyon
20230536	970	8	8 fruits to NTBG Kahanu	TBD	–	Kahanu
20230531	968	13	3 fruits to NTBG Kahanu; 10 fruit to Lyon	9 Lyon, 0 KG	0%	Kahanu/Lyon
20230530	968	19	9 fruits to NTBG Kahanu 10 to Lyon Arboretum	2 Lyon, 4 KG	44%	Kahanu/Lyon
TOTALS	–	198	(126 fruits to Kahanu)	48 plants (19 KG sown)	15%	–

Table 1: Total fruit collections and living seedlings.

Table 2: Lyon Micropropagation facility Propagation Data

NTBG Accession	Date Rec'd	# Fruit Rec'd	# Embryo Sown	# Plants Sent to Kahanu	% fruits reach germination	Sent Date	Plants to grow at Lyon
20230207	5/22/2023	10	10	5 (8 germinated, but 3 did not survive transition)	80%	2/12/2024	0
20230530	11/15/2023	10	10	2	20%	4/9/2024	0
20230531	11/15/2023	10	10	6	60%	4/9/2024	2
20230537	11/15/2023	38	14	10	26%	4/9/2024	2
20230538	11/15/2023	4	4	2	50%	4/9/2024	0
Total	—	72	48	25	34% (52% of embryo sown)	—	4

dry embryos with laminar airflow before cryopreservation, use a range of drying times to determine the optimal duration especially when the species has not been tested before or the exact maturity level is not known.

Hawaiian *Pritchardia* are some of the archipelago's most iconic plant species, emerging from above forest canopies in an idyllic fashion. Their cultural uses (hats, roofing, fruit meat) and generally high regard within contemporary Hawaiian life (i.e. planting near Heiau) speaks to their biocultural significance. Resources to mitigate Coconut Rhinoceros Beetles (CRB) in the Hawaiian Islands need to be increased or ancient forests featuring Hawaiian *Pritchardia* will forever be changed. The nearly 50 germinated seedlings that were produced from this project will be planted at NTBG's Kahanu Garden and Preserve in Hāna, Maui, with some plants being planted at Lyon Arboretum for cultivation and additional ex situ representation there.

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Beccariophoenix madagascariensis **Rediscovered in its Type Locality**

WILLIAM J. BAKER^{1,2}, WOLF L. EISERHARDT^{1,2} AND
MIJORO RAKOTOARINIVO³

Beccariophoenix madagascariensis has been refound in the well-known Analamazaotra reserve in Madagascar for the first time for more than a century.

Beccariophoenix madagascariensis is among the most iconic of Madagascar's palms, and its rediscovery (Dransfield 1988) was one of the triumphs of the intrepid fieldwork that underpinned the publication of *The Palms of Madagascar* (Dransfield & Beentje 1995). It was first collected by Perrier de la Bâthie in Analamazaotra, now a national park near Andasibe, and then described in 1915 (Jumelle & Perrier de la Bâthie 1914 [published 1915]) based on that material (termed the "type" specimen). Since that time, it has been found in scattered populations nearby in Mantadia

National Park (Dransfield 1988) and in community protected areas at Maromizaha and Vohimana, as well as in sites much further south at Vondrozo and Fort Dauphin. Initially assessed as "critical" (Dransfield & Beentje 1995), *B. madagascariensis* is now treated as Vulnerable on the IUCN Red List (Rakotoarinivo & Dransfield 2012). However, in its type locality at Analamazaotra, it has not been seen since the type collection by Perrier de la Bâthie – until now.

During a joint research expedition to Madagascar involving scientists from the Royal Botanic Gardens, Kew, the University of Antananarivo, Aarhus University, the German Centre for Integrative Biodiversity Research (iDiv), Leipzig and l'Institut de Recherche pour le Développement (IRD), Montpellier, a single, robust juvenile (Figs. 1–3) was located in the north of Analamazaotra. It was found on a path accessible only to rangers and researchers, rather than on one of the network of public

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1. *Beccariophoenix madagascariensis* – a lone individual located in Analamazaotra (Photo: W.J. Baker).



2. The apical leaflets of *Beccariophoenix madagascariensis* – united with windows (Photo: W.J. Baker).

paths that have been extensively explored for palms over the years. The massive, litter-trapping, stemless individual was quickly identified as *Beccariophoenix* (rather than a *Ravenea* juvenile, also common in the area), due to the pronounced cross-veins and asymmetrical apex of the leaflets and the apical leaflets being united with window-like splits at the base. No other specimens were sighted on this path. Sterile voucher specimens were prepared for deposition in the herbaria in Antananarivo and Kew. While the existence of this remarkable palm in Analamazaotra is no surprise, the fact that it persists is an important piece of new information in our growing understanding of its distribution in the Andasibe area and its prospects for the future. We were fortunate to see about ten juveniles in nearby Maromizaha reserve a couple of days later, and local guides reported that adults remain both in that reserve and also in Mantadia.

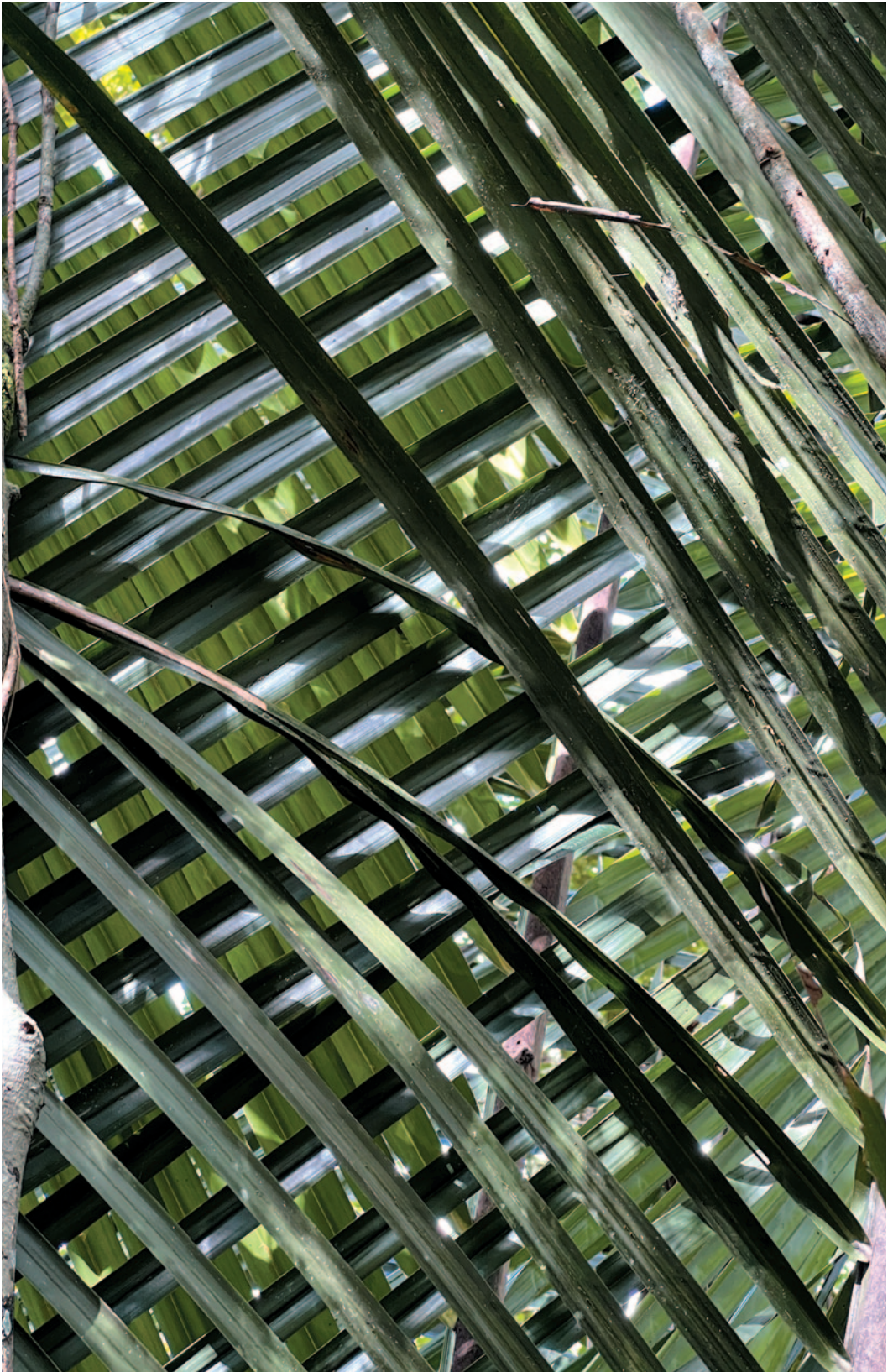
Acknowledgments

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3. Leaflets of *Beccariophoenix madagascariensis* in Analamazaotra (Photo: W.J. Baker).

Jubaeopsis afra – A New Name for an Old Species

WILLIAM J. BAKER¹

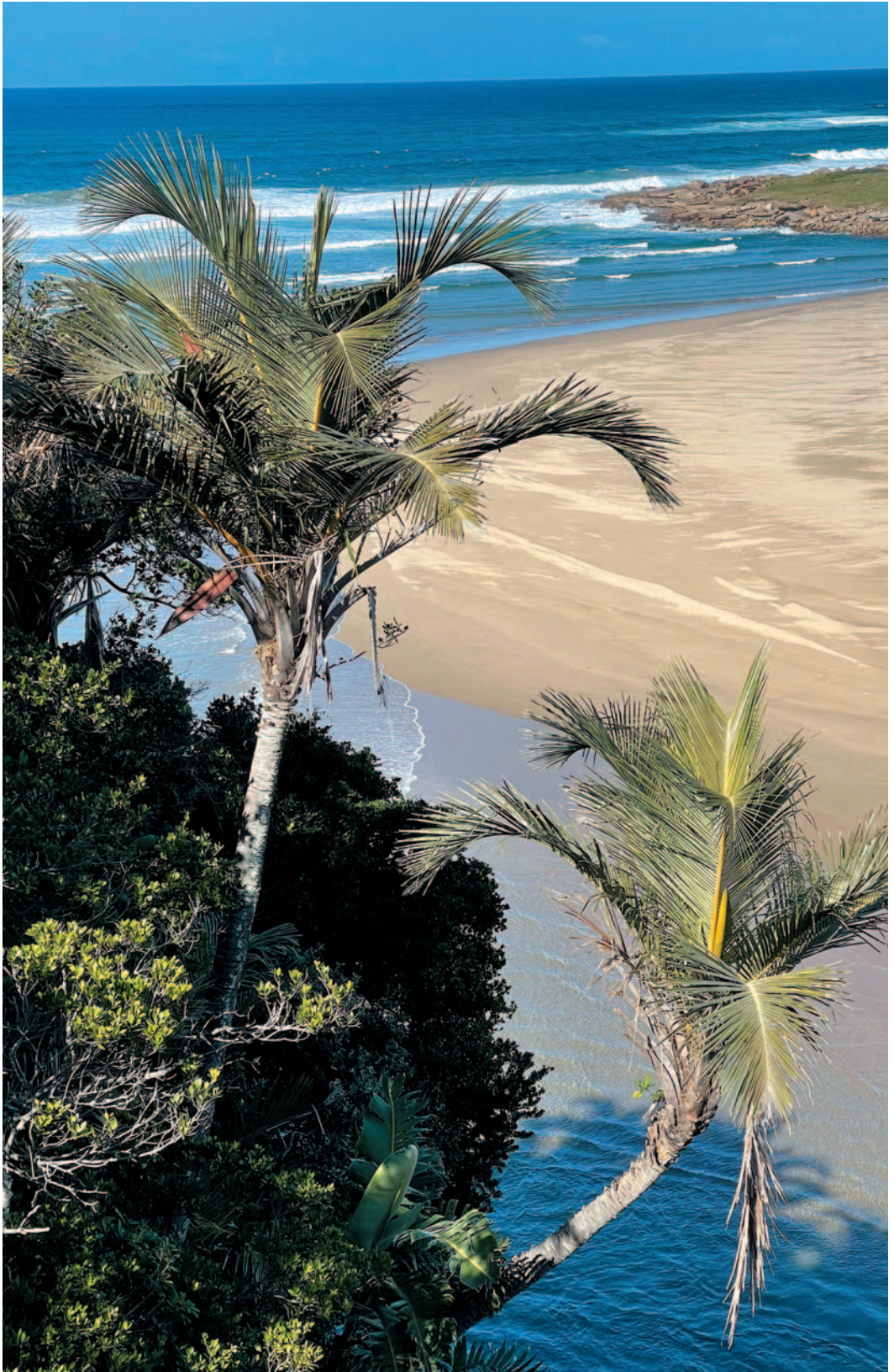
As a result of deliberations by the Nomenclature Section of the 20th International Botanical Congress, which took place on 15–19 July 2024 in Madrid, a well-known palm, *Jubaeopsis caffra* from South Africa, has changed its name to *Jubaeopsis afra*. The International Botanical Congress meets every six years and is the leading international forum for the botanical community. Every Congress is preceded by the week-long meeting of the Nomenclature Section at which proposals to amend the International Code of Nomenclature, the rules that govern the naming of algae, fungi and plants, are debated and voted upon. Among the 433 proposals discussed this year, the most controversial related to the changing of offensive or culturally inappropriate names and attracted widespread attention in the global media. The Nomenclature Section approved a proposal to change all botanical names based on the root caff[e]r (or caf[e]r) (Smith & Figueiredo 2021). These names are derived from a word that was originally used by botanists to denote a plant's African origins without offensive intention, but has since become a serious racial slur for people from Africa or of African heritage (Norris 2004). All such names were changed with immediate effect at the Congress,

dropping the “c” and “f” where necessary such that “*caffra*” becomes “*afra*.” The plant species epithets *afra* or *afrum* are already used in other plant names to indicate African geographical origins. Other proposals to allow the rejection of culturally offensive and inappropriate names were not passed in full (Hammer & Thiele 2021), but a mechanism to propose names for rejection if they are derogatory to a group of people will be enacted from 2026 onward. As the recent changes to the names of many palm species formerly included in *Dypsis* demonstrate, palm enthusiasts are adaptable and swift to accommodate nomenclatural change, and will no doubt quickly adopt this change in *Jubaeopsis*.

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1. *Jubaeopsis afra* in its spectacular South African habitat (Photo: Troos van der Merwe CC BY-NC 4.0).



2. *Jubaeopsis afra* is still uncommon in cultivation (Photo: M.D. Ferrero).

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