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Editors: William J. Baker, w.baker@kew.org
Scott Zona, scott.zona@yahoo.com

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FRONT COVER

Colpothrinax cookii. See article by M.Á. Pérez-Farrera et al., p.109. Photo by Miguel Ángel Pérez-Farrera.

BACK COVER

A clustering *Phoenix atlantica* with dark green leaves, a Cape Verde endemic palm, Boa Vista Island, Fogão, with invasive *Prosopis juliflora* on the left. See article by L. Noblick and I. Gomes, p. 142. Photo by L. Noblick.

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The natural range of *Colpothrinax cookii* is now known to include Oaxaca, Mexico. See article by M.A. Pérez-Farrera et al., p. 109. Photo by Mauricio Gerónimo Martínez-Martínez.

PALM NEWS

Researchers have described a new species of *Syagrus* from the Serra do Ambrósio of Minas Gerais, Brazil. *Syagrus harenae* is similar to *S. glaucescens* but has smaller leaves, flowers grouped in fours and fives and orange fruits. There are also differences in the leaf anatomy. This finding also supports the idea that the Diamantina Plateau, where Serra do Ambrósio is located, is a hotspot for *Syagrus* palm diversity. Sadly, *Syagrus harenae* is considered critically endangered. The publication is freely accessible: Sant'Anna-Santos et al. 2025. Hidden in the mountain: a new rare *Syagrus* (Arecaceae) with morphological novelties. *Plant Ecology & Evolution* 158: 63–81. <https://doi.org/10.5091/plecevo.140657>

Andrew Henderson and Christine Bacon revisited the taxonomy of *Iriartella*, a genus native to a wide area of the western and central Amazon Basin. A careful examination of floral characters on herbarium specimens validates the recognition of two species. *Iriartella stenocarpa* has imbricate staminate and pistillate sepals; whereas, *I. setigera* has cup-like staminate and pistillate calyces. The publication is: Henderson & Bacon. 2025. *Iriartella* (Arecaceae, Iriarteae) reconsidered. *Phytotaxa* 710: 127–130. <https://doi.org/10.11646/phytotaxa.710.1.8>



A new molecular phylogenetic hypothesis for the Coryphoidae has been published. This one differs from its predecessors by the dense sampling of species (ca. 80% of the subfamily) and the number of nuclear gene sequences (971 genes vs. ca. 10). The new analysis confirms some well-supported groups, provides more evidence that *Caryota*, *Arenga* and *Wallichia* are not currently well classified, and the enigmatic *Livistona exigua* needs re-examination. The study is by Wrisberg et al. and is forthcoming in *Taxon*. <https://doi.org/10.1002/tax.13384>



The III Brazilian Palm Symposium will be held in Ilhéus, Bahia, Brazil, October 24–26, 2025. The organizers, the Brazilian Palm Society, will bring together a lineup of international and Brazilian speakers, tours of important palm collections and two social dinners. The official languages of the symposium will be Portuguese and Spanish. For more information, please contact the organizers on WhatsApp at +55 17 997628602.

Colpothrinax cookii: A New Record for Mexico

MIGUEL ÁNGEL PÉREZ-FARRERA¹, HÉCTOR GÓMEZ DOMÍNGUEZ²,
DIEGO VILLAR-MORALES^{3*}, MAURICIO GERÓNIMO MARTÍNEZ-
MARTÍNEZ¹ AND GASPAR MORENO MÉNDEZ¹

Considered one of the world's megadiverse countries, Mexico harbors ca. 23,000 indigenous vascular plant species. Palms are represented by 21 genera and about 100 species. During recent fieldwork in the Selva Zoque region, on the state border of Chiapas and Oaxaca, several palms were collected and later identified as *Colpothrinax cookii*. Previously, this species had been recorded only from Belize, Guatemala and Honduras, making this discovery its first record for the Mexican flora. The addition of *Colpothrinax* raises the number of indigenous genera recognized in Mexico from 21 to 22 and expands the known distribution of the species.

Mexico is among the top four richest countries in indigenous and endemic flora of the world (Villaseñor 2016). According to recent estimates and checklists, Mexico has between

23,000 and 29,000 indigenous species, around 50% of them being endemic (Villaseñor 2016, Sosa et al. 2023). The physiographic and climatic diversity of the country, along with its geographic position acting as a crossroads between holarctic and neotropical floras, are known to be the main causes of its vast plant and vegetation diversity (Rzedowski 1978, Morrone 2019). The study of the Mexican flora is still an ongoing effort by taxonomists and botanists in both laboratory and field work.

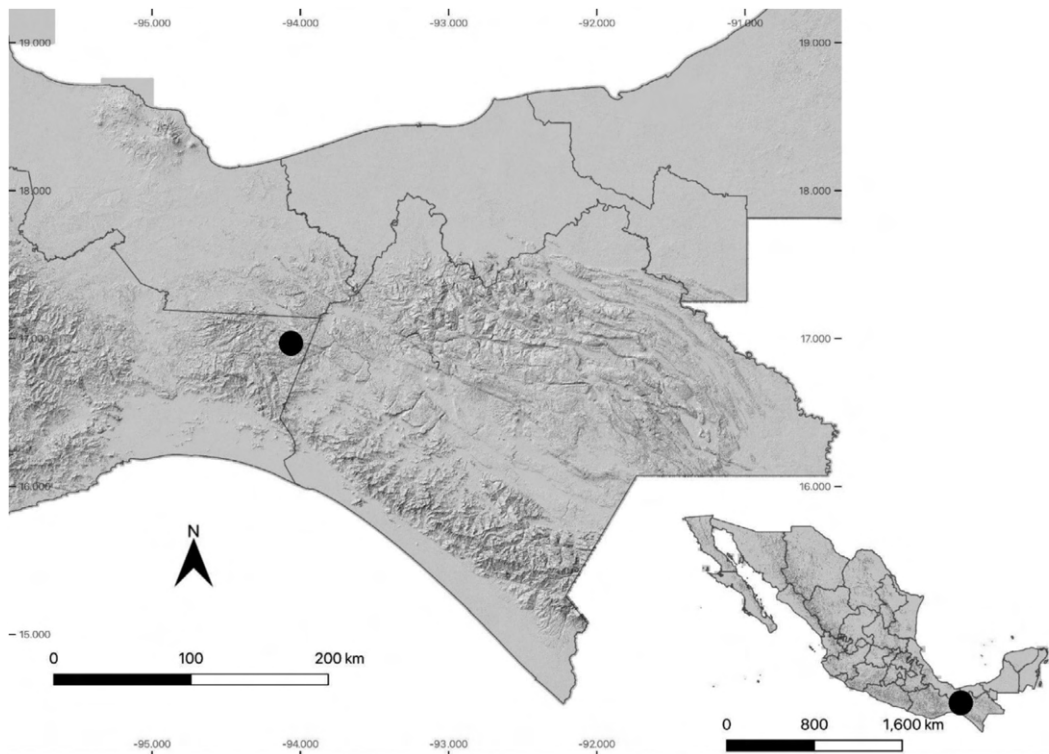
The palm family is represented in Mexico by 21 genera and ca. 100 species, 37 of them being endemic (Pulido-Silva et al. 2022). Three genera are particularly diverse in the country with high species count: *Chamaedorea*, *Brahea* and *Sabal*. As with the rest of floral elements, the Mexican palm flora is also a composite of

¹Herbario Eizi Matuda, Laboratorio de Ecología Evolutiva, Instituto de Ciencias Biológicas, Universidad de Ciencias y Artes de Chiapas, Tuxtla Gutiérrez 29039, Mexico

²Fondo de Conservación El Triunfo A.C., Tuxtla Gutiérrez 2900, Mexico

³Instituto de Biología, Universidad Nacional Autónoma de México, Mexico City 04510, Mexico

*Author for correspondence:
dgo.vimo@gmail.com



1. Map showing the study and collection site in Oaxaca, Mexico.

different origins, mainly with holarctic elements represented by coryphoid palms and a neotropical component of arecoid palms (Baker & Couvreur 2013). The richest areas of palm diversity in Mexico have been reported in the states of Chiapas, Oaxaca and Veracruz (Pulido-Silva et al. 2022).

On the limits of these states lies the Selva Zoque (Zoque Rainforest), considered one of the floristically richest regions in southern Mexico with over 3,000 indigenous vascular plant species and high endemism (Pérez-Farrera et al. 2016). The Selva Zoque encompasses various areas, some of them with protected status, such as the Chimalapas-Uxpanapa forests, El Ocote Biosphere Reserve, Cañon del Sumidero National Park and the Priority Conservation Area La Sepultura, all of which have been noted for their high biodiversity (Peterson et al. 2003, Lira-Torres et al. 2011, Aguilar-López 2021). Most of its extent is covered by evergreen and semi-evergreen tropical forests, followed by smaller areas of deciduous tropical forests, tropical montane cloud forests and pine-oak forests (Pérez-Farrera et al. 2016). Although well-preserved forests still exist, especially in the protected areas, the Selva Zoque is threatened

by various anthropogenic factors (Rodríguez Olivet & Asquith 2004, Pérez-Farrera et al. 2016).

During a botanical exploration made in 2022, deep in the Chimalapas forest of the Selva Zoque on the limits of Oaxaca and Chiapas (Fig. 1), we observed tall, fan-leaved palms emerging from the forest canopy (Fig. 2). These palms were outstanding observations, since the only other palms known to this region were all species of pinnate-leaved genera, such as *Attalea*, *Astrocaryum*, *Chamaedorea* and *Reinhardtia*. We took photographs and collected leaves of these striking palms for further investigation; however, no reproductive structures were found. One year later we had the opportunity to return to the area and, after doing the same 13 km hike through the forest, we found both flowers and young fruits on the individuals. After comparing the collected material and field observations with herbarium specimens and descriptions in the literature, these palms were identified as *Colpothrinax cookii* Read, a species previously only recorded in Guatemala, Belize and Honduras (Evans 2001). Here we describe this record of a new genus for the flora of Mexico.



2. Individuals of *Colpothrinax cookii* emerging from the canopy on a forested slope.

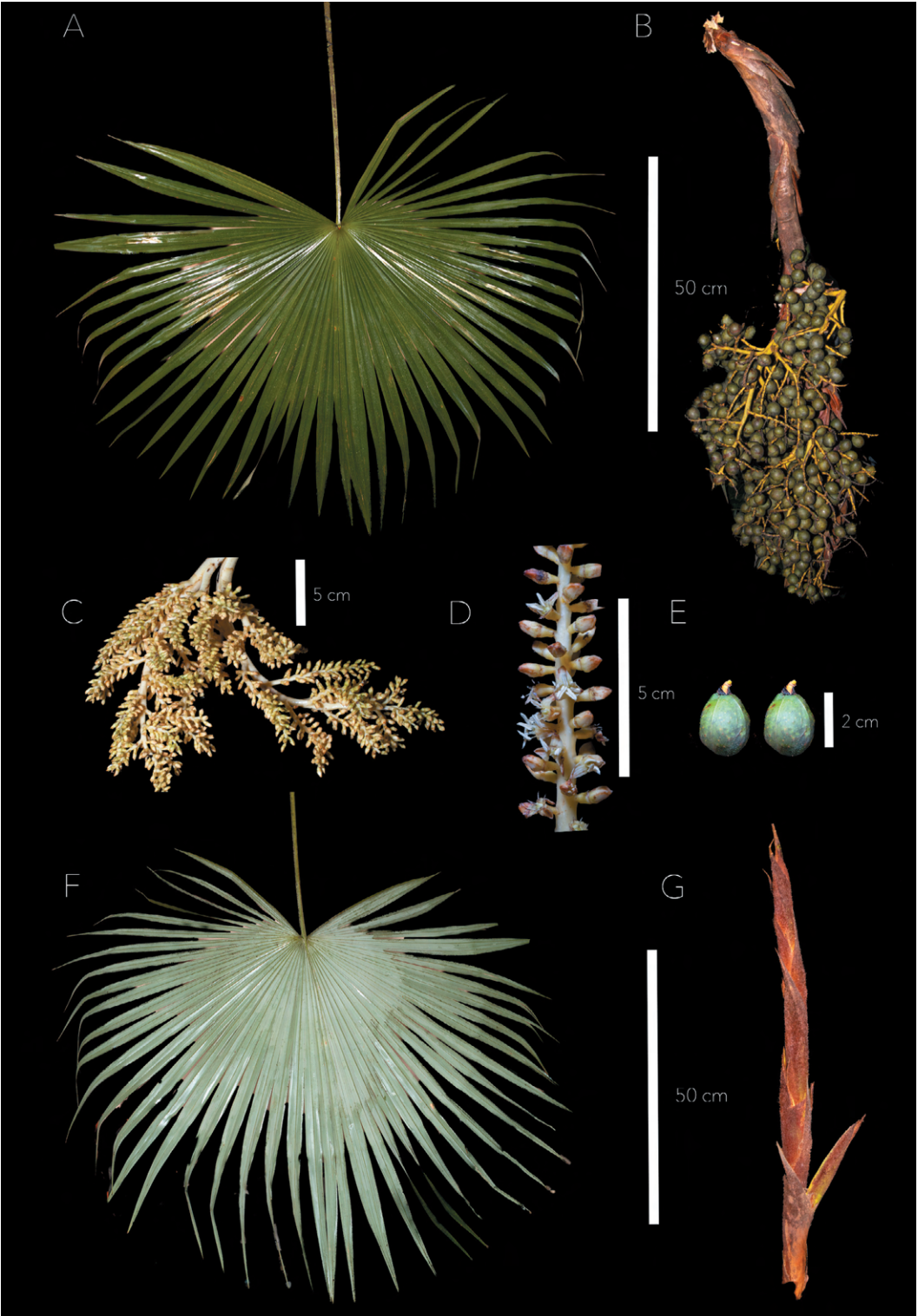
Taxonomic description

Colpothrinax cookii Read, Principes 12: 13 (1969). Type: GUATEMALA. Alta Verapaz: Finca cafetalera Sepacuite, al norte de Panzós, en la vertiente norte de la principal cadena montañosa atravesada saliendo del Valle del Polochic, 1200 m, 22 March 1902, *Cook & Griggs 116* (holotype US!; isotype BH) (Figs. 2–6).

Trunk 8–25 m tall, erect, columnar, 15–35 cm DSH, usually naked, upper portion partially or entirely enclosed in a mat of persistent leaf-sheath fibers, trunks of juveniles less than 4–8 m tall, upper portion usually completely covered by leaf-sheath fibers and dry petioles (Fig. 4). Leaves 8–25, costapalmate; sheath tomentose, proximal end with sparse, coarse trichomes 1 mm long, beige, progressively covered with denser tomentum towards the distal end, there trichomes up to 9 mm long, reddish, the sheath disintegrates and frays into fine, hanging, loose, typically terete fibers (Fig. 4); petiole 1.5–2.5 m long, 2.3–3.4 cm wide at attachment to blade; adaxial hastula slightly elevated above the blade, 2–3 × 2–4 cm, 1 to 1.5 times wider than long, regularly triangular, usually with an acuminate apex; costa 15–25 cm long; blade 100–180 cm long centrally, 70–150 cm long laterally, divided into single-fold segments, the central division extending up to 57–60 cm from the base, the lateralmost division extends up to 11.5–19 cm from the

base, 19–21 segments per blade half, the widest 4–4.6 cm wide, glabrous and green adaxially, glaucous abaxially (Fig. 3F). Inflorescences with approximately 80 flowers or fruits; primary axis 1–2 m long; inflorescence bracts woolly (Fig. 3B, 3G), with trichomes 5 mm long; peduncle 0.4–1 m long; prophyll approximately 11 × 4 cm, peduncular bracts 13 × 5.2 cm; rachis 36 × 4.9 cm; rachis bracts 28 × 10 cm; first-order branches 6–9; axes creamy yellow (Fig. 3C), with primary axes 18–55.2 cm long, with an unbranched proximal portion 12.3–26.2 cm long and a branched distal portion 6.5–10.3 cm long; rachillae typically 10–12 per basal first-order branch, 15–19 per apical first-order branch, 5.3–12.5 cm long, tomentose, trichomes 3.4–4.18 mm long. Floral receptacle 0.5–1.5 mm long; calyx 2.5–5 mm long, free distally from the corolla, creamy yellow in color, lobes 0.5 mm long; corolla 4.0–6.0 mm long, connate at the base; stamen cup shorter or the same length as the calyx cup, filaments cream-colored, anthers 2.5–3.0 × 1.0 mm, coarsely perforated to reticulate; gynoecium and styles cream-colored (Fig. 3D). Fruits 1.5–2.0 cm diam. (Fig. 3E); seed 1.0 × 1.5 cm.

Distribution: Mexico, on the border between Chiapas and Oaxaca, from 500–1,100 m asl, in lowland, evergreen rainforest. In Belize, Guatemala and Honduras, this species grows between 700–1,200(–1,600) m asl in premontane forests and sometimes in lower



3. Morphology of *Colpothrinax cookii*. A) leaf, adaxial view, B) infructescence, C) flowering rachillae, D) rachilla with flowers, E) fruits, F) leaf, abaxial view, G) inflorescence in bud covered by peduncular bracts.

montane, wet forests on the Caribbean slope (Evans 2001).

Habitat: *Colpothrinax cookii* grows in both conserved and deforested, lowland, evergreen



4. Juvenile of *C. cookii* with dry petioles and sheath fibers covering the upper portion of the trunk.

rainforest (Fig. 2, 5, 6) These palms stand out for their height, often exceeding the forest canopy. In this area, *C. cookii* is sympatric with other palm species such as *Astrocaryum mexicanum*, *Attalea butyracea*, *Calyptrogyne*

ghiesbreghtiana, *Chamaedorea alternans*, *C. arenbergiana*, *C. ernesti-augusti*, *C. pinnatifrons*, *C. tepejilote*, *C. tuerckheimii*, *Reinhardtia elegans* and *Synechanthus fibrosus*. The arboreal stratum in the conserved areas is represented by



5. Individuals of *C. cookii* on a cleared slope.

Swietenia macrophylla, *Inga* sp., *Hoffmannia rzedowskiana*, *Cedrela odorata*, *Trophis* sp., *Ficus* sp., *Bursera simaruba*, *Oreopanax* sp., *Dendropanax* sp., *Brosimum alicastrum* and *Trichilia* sp. In the shrub and herbaceous stratum, it is common to find individuals of *Asplundia* sp., *Carludovica palmata*, *Tillandsia* sp., *Maxillaria* sp., *Anthurium huixtlense*, *A. schlechtendalii* Kunth, *Anthurium* sp. and *Spathiphyllum* sp. The region is characterized by granite and metamorphic rocks and reddish-clay soil (luvisol and vertisol).

Specimens examined: MEXICO. Oaxaca: Santa María Chimalapa, Ejido San Juan, 1,080 m asl, 22 July 2022, Gómez-Domínguez H. 3916 (HEM!), 3917 (HEM!); San Juan del Río, 850 m asl, 22 January 2023, Martínez-Mtz M.G. 042 & Pérez-Farrera M.A., Villar-Morales D., Gómez-Domínguez H. (HEM!); Pérez-Farrera M.A. 4301 & Villar-Morales D., Gómez-Domínguez H., Martínez-Mtz M.G. (HEM!).

Discussion

Colpothrinax is a monophyletic genus of hermaphroditic palms that has three species with a disjunct distribution: *C. wrightii* is endemic to Cuba, *C. aphanopetala* is distributed in central-south Central America (Costa Rica, Nicaragua and Panama) and *C. cookii* can be found in Belize, Guatemala, Honduras and southern Mexico (Evans 2001, Bacon et al. 2012). A recent phylogeny has placed it, along with *Copernicia* and *Pritchardia*, in a clade sister to the rest of the other members of tribe Trachycarpeae (Yao et al. 2023).

Fossil evidence suggests that the genus *Colpothrinax* was part of the flora of southern Mexico during the mid-Tertiary period (Chambers et al. 2012). The fossil species *Colpothrinax chiapensis*, described from flowers embedded in amber from the Late Oligocene to Early Miocene, is proposed by Chambers et al. (2012) probably to belong to the stem group of the genus. The original vegetation of the locality where the amber was found, adjacent to the Selva Zoque, has been described as a tropical rainforest according to paleoclimatic and vegetation reconstructions (Hernández-Hernández et al. 2020).

Currently, the Los Chimalapas area in the Selva Zoque is considered to be a Pleistocene floristic refugium in southern Mexico (Wendt 1987). The complex topography of the region allows for a high heterogeneity of climates and contiguous ecosystems, such as low deciduous forests, xerophilous scrublands, pine and oak forests, tropical evergreen forests and cloud forests (WWF and IUCN 1997, Salas-Morales et al. 2001). This area has many species that are either endemic or with a restricted distribution, such as palms *Chamaedorea tuerckheimii* and *Reinhardtia elegans*, cycads *Ceratozamia chimalapensis* and *C. euryphyllidia* (Gutiérrez-Ortega et al. 2024), *Zamia purpurea* (Vovides et al. 1983), and magnolias *Magnolia chimalapana*, *M. heriberto* and *M. uxpanapana* (Vázquez-García et al. 2024). Such diversity can be associated with the Pleistocene refugia hypothesis (Wendt 1987), the presence of



6. Population of *C. cookii* in San Juan del Rio, Oaxaca, Mexico.

Colpothrinax cookii being a good example of this, considering the fossil distribution of the genus in Mexico.

This discovery broadens the distribution of the species and brings the number of palm genera in Mexico from 21 to 22 and species from 99

to 100 (Pulido-Silva et al. 2022). However, we consider that the species count could increase to about 110 based on preliminary field and herbarium work that is still ongoing. Phytogeographic, genetic and ecological studies of this recently detected population of *C. cookii* could generate new information that will lead to a better understanding of the biogeographical history of the genus and urgent conservation in Mexico.

Acknowledgments

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LITERATURE CITED

- AGUILAR-LÓPEZ, J.L., LURÍA-MANZANO, R., PINEDA, E. AND CANSECO-MÁRQUEZ, L. 2021. Selva Zoque, Mexico: an important mesoamerican tropical region for reptile species diversity and conservation. *ZooKeys* 1054: 127–153.
- BAKER, W.J. AND COUVREUR, T.L.P. 2013. Global biogeography and diversification of palms sheds light on the evolution of tropical lineages. II: Diversification history and origin of regional assemblages. *Journal of Biogeography* 40: 286–298.
- BACON, C.D., BAKER, W.J. AND SIMMONS, M.P. 2012. Miocene dispersal drives island radiations in the palm tribe Trachycarpeae (Arecaceae). *Systematic Biology* 61: 426–442.
- CHAMBERS, K.L., POINAR JR., G.O. AND BROWN, A.E. 2012. A new fossil species of *Colpothrinax* (Arecaceae) from Mid-Tertiary Mexican amber. *Journal of the Botanical Research Institute of Texas* 6: 557–560.
- EVANS, R.J. 2001. Monograph of *Colpothrinax*. *Palms* 45: 177–195.
- GUTIÉRREZ-ORTEGA, J.S., ET AL. 2024. The phylogenetic reconstruction of the Neotropical cycad genus *Ceratozamia* (Zamiaceae) reveals disparate patterns of niche evolution. *Molecular Phylogenetics and Evolution* 190: 107960.
- HERNÁNDEZ-HERNÁNDEZ, M.J., CRUZ, J.A. AND CASTAÑEDA-POSADAS, C. 2020. Paleoclimatic and vegetation reconstruction of the Miocene southern Mexico using fossil flowers. *Journal of South American Earth Sciences* 104: 102827.
- LIRA-TORRES, I., GALINDO-LEAL, C. AND BRIONES-SALAS, M. 2011. Mamíferos de la Selva Zoque, México: riqueza, uso y conservación. *Revista de Biología Tropical* 60: 781–797.
- MORRONE, J.J. 2019. Regionalización biogeográfica y evolución biótica de México: encrucijada de la biodiversidad del Nuevo Mundo. *Revista Mexicana de Biodiversidad* 90: e902980.
- PÉREZ-FARRERA, M.A., ESPINOSA JIMÉNEZ, J.A., LÓPEZ, A., GÓMEZ DOMÍNGUEZ, H. AND GORDILLO RUIZ, M.C. 2016. Flora y vegetación de la Selva Zoque de Chiapas. Pp. 52–76, in ESQUINCA CANO, F. AND GORDILLO RUIZ, M.C. (eds.). *Ecoregión Zoque: Retos y Oportunidades ante el Cambio Climático*. SEMAHN, Tuxtla Gutiérrez, Mexico.
- PETERSON, A.T. ET AL. 2003. The Chimalapas Region, Oaxaca, Mexico: a high-priority region for bird conservation in Mesoamerica. *Bird Conservation International* 13: 227–253.
- PULIDO-SILVA, M.T., QUERO, H., HODEL, D. AND LÓPEZ-TOLEDO, T. 2022. Richness, endemism and floristic affinities of the palms of Mexico. *The Botanical Review* 89: 250–274.
- RODRIGUEZ OLIVET, C. AND ASQUITH, N. 2004. Northern Region of the Mesoamerica Biodiversity Hotspot, Belize, Guatemala, Mexico. Conservation International, Critical Ecosystem Partnership Fund, Washington DC, USA.
- RZEDOWSKI, J. 1978. Vegetación de México. Limusa, Mexico, D.F., Mexico
- SALAS-MORALES, S.H., SHIBLI, L. AND TORRES BAHENA, E. 2001. La importancia biológica y ecológica. Pp. 27–47, in APARICIO, R. (ed.). *Chimalapas: la Última Oportunidad*. WWF Mexico and SEMARNAP, Mexico City, Mexico.
- SOSA, V. et al. 2023. The online Flora of Mexico: EFloraMEX. *Botanical Sciences* 101: 324–340.
- VÁZQUEZ-GARCÍA, J.A., PADILLA-LEPE, S., GALLARDO-YOBAL, S., RODRÍGUEZ-PÉREZ, C., GARCÍA-ESCOBAR, A. AND MUÑOZ-CASTRO, M.A. 2024. Three new Mesoamerican species of *Magnolia* (M. sect. *Talauma*, Magnoliaceae) from the Chimalapas-Uxpanapa region, Mexico. *Phytotaxa* 652: 10–32.

- VILLASEÑOR, J.L. 2016. Checklist of the native vascular plants of Mexico. *Revista Mexicana de Biodiversidad* 87: 559–902.
- VOVIDES, A.P., REES, J.D. AND VAZQUEZ-TORRES, M. 1983. *Zamiaceae*, in GÓMEZ-POMPA, A. (ed.). *Flora de Veracruz*. INIREB, Xalapa, Mexico.
- WENDT, T. 1987. Las selvas de Uxpanapa, Veracruz-Oaxaca, México: evidencia de refugios florísticos cenozoicos. *Anales del Instituto de Biología, Serie Botánica* 58: 29–54.
- WWF AND IUCN. (1997). *Centres of Plant Diversity, A Guide and Strategy for their Conservation*, Vol. 3, The Americas. IUCN Publications Unit, Cambridge, UK.
- YAO, G., ET AL. 2023. A plastid phylogenomic framework for the palm family (Arecaceae). *BMC Biology* 21: 50
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Human Legacies on Palms in Belize

CHRISTINE D. BACON^{1, 2}, STEVEN BREWER³, SARA ESHLEMAN⁴,
KEITH PRUFER⁵ AND MARK ROBINSON⁴

We visited the Bladen Nature Reserve in the Maya Mountains of Belize to study palms and other forest plant species important to Maya communities. We observed and collected most of the 24 palm species found in the reserve. Our main objective was to collect material to understand how plant communities changed through time in response to the rise and fall of Maya settlements, and palms form a major component of those communities

Human impacts on biodiversity have occurred over millennia. Past human societies transformed habitats, converting land for subsistence and resource extraction, engineering landscapes to control hydrology, soil fertility and agricultural production, and creating urban centers to support growing populations. These transformations had great implications for the biodiversity patterns we see in nature today. Indeed, the idea that there are still “wild”, untouched habitats on Earth today is likely inaccurate (Ellis et al. 2021). One such case is Amazonia, the largest tract of

tropical rainforest on Earth. Recent evidence suggests that the abundance of most common Amazonian species is due to human use (Levis et al. 2017). Even in current societies, more than 80% of Amazonian tree and palm species are categorized as useful to humans (Coelho et al. 2021). The economic importance and variable uses of palms have been long studied, in Amazonia and beyond (for example, from Wallace 1853 to Cámara-Leret et al. 2019). From the initial human colonization into Amazonia, palms were an essential subsistence resource (Morcote-Rios et al. 2021, Robinson et al. 2021). How has this legacy of human use over deep time scales impacted palm populations and forests in general?

The abundance of a palm species results from and facilitates the availability of fruits, fibers, leaves and other non-timber forest products; the more abundant a species is, the more it is used, which in turn increases its abundance (McSweeney 1995). Previous research into an important non-timber forest product of Belize examined the genetic variation through time

¹University of Gothenburg, Gothenburg, Sweden.

²Gothenburg Global Biodiversity Centre, Gothenburg, Sweden.

³Wild Earth Allies, Chevy Chase, USA.

⁴University of Exeter, Exeter, United Kingdom.

⁵University of New Mexico, Albuquerque, USA.

of *Chamaedorea ernesti-augusti* (Fig. 1; Cibrián-Jaramillo et al. 2009). While harvest of leaves for the international floral market has changed population dynamics of this species in recent history (Bridgewater et al. 2006b), on longer time scales, Maya societies also cultivated large swaths of land for food and other resources (e.g. Prufer et al. 2021). This included 479 species of domesticated and managed edible plants, including at least 26 species of palms (Fedick 2021). Human-mediated habitat change had effects on sensitive understory palm species, which were part of the local diet, such as *Bactris* (three species consumed), *Chamaedorea* (six species consumed) and *Geonoma* (one species consumed; Fedick 2021). Genetic data from *C. ernesti-augusti* individuals sampled across Belize were used to model demographic change and test whether changes occurred at times relevant to Maya society population increase and subsequent collapse (Cibrián-Jaramillo et al. 2009). While no signal was detected related to Maya deforestation, this study exemplifies the use of genetic diversity as a tool to understand human legacies on palms.

An alternative approach to understanding human legacies on palms is to study the fossil record. Evidence of species turnover through time can be identified from lake sediment core data and terrestrial soil test pits, where diagnostic pollen and phytoliths indicate species presence and abundance through time. These paleoecological records can be dated, taxonomically identified and counted, and then interpreted in light of archaeological data on human presence and activities. Human legacy is largely invisible in the Mesoamerican paleoecological records until about 4,000 years ago, but it is not clear whether this is due to a lack of preserved and studied contexts or because only then did Maya societies fill the landscape and change their surroundings (Ford 2022). The Classic Period Maya society (A.D. ~250–850) is characterized by their advanced hieroglyphic writing, art and architecture. Their extensive and populous network of cities and towns were present across five modern countries (Belize, El Salvador, Guatemala, Honduras, and Mexico).

Maya societies can provide a framework, where paleo- and historical data can inform contemporary global environmental change and sustainability. This is the focus of our new project, where we aim to combine archaeology, paleoecology, botany, plant genetics, geochemistry, remote sensing and ecological



1. *Chamaedorea ernesti-augusti* at the Bladen Nature Reserve in the Maya Mountains. The characteristic bifid leaf shape indicates its species identity, since comparatively few *Chamaedorea* species are bifid and all other *Chamaedorea* in the Bladen are pinnate-leaved. Photo: Christine Bacon.

modelling. Ancient and modern vegetation proxies at high spatial and chronological resolution will be used to assess long-term human impacts on biodiversity in a tropical forest ecosystem at a landscape scale. The project is focused on the Bladen Nature Reserve, southern Belize. Southern Belize was home to over 30 Maya polities occupying a vastly productive agricultural landscape during the Classic Period (Prufer & Kennett 2020). Rock shelters in the region record 13,000 years of human occupation, from initial entry, through the adaptation of agriculture, rise of the monumental Classic Maya civilization and subsequent collapse 1000 years BP (Prufer 2005). The inaccessibility of the remote location means that it has experienced minimal human disturbance over the last millennium since the area was abandoned.

The flora of the Maya Mountains, where the Bladen Nature Reserve is located, has been relatively well studied (e.g. Iremonger et al. 1995, Brewer & Webb 2002, Calonje et al. 2024). The palm species diversity in Belize totals 38 species (Henderson et al. 1995, Brewer 1996, Bridgewater et al. 2007), in the Bladen there are 24 species (updated list based on



2. *Astrocaryum mexicanum* is the only species in the genus distributed in Belize. Photo: Steven Brewer.

Iremonger et al. 1995): *Acoelorrhaphe wrightii*, *Astrocaryum mexicanum* (Fig. 2), *Attalea cohune*, *Bactris mexicana* (Fig. 3), *Calyptronyne ghiesbreghtiana*, *Chamaedorea costaricana*, *Chamaedorea ernesti-augusti* (Fig. 1), *Chamaedorea neurochlamys* (Fi. 4), *Chamaedorea oblongata*, *Chamaedorea schippii*, *Chamaedorea seifrizii*, *Chamaedorea tepejilote*, *Colpothrinax cookii*, *Cryosophila stauracantha*, *Desmoncus chinantlensis* (Fig. 5), *Euterpe precatoria*, *Gaussia maya*, *Geonoma deversa*, *Geonoma interrupta* subsp. *magnifica* (Henderson 2011; Fig. 6), *Geonoma pinnatifrons* subsp. *mexicana*, *Sabal mauritiiiformis* (Fig. 7), *Schippia concolor*, *Synecanthus fibrosus* and *Thrinax radiata*.

We traveled to the Bladen Nature Reserve in May 2024 to collect archaeological, botanical and paleoecological data. Our team of nine scientists, five guides from the local Maya community, one forest ranger from the Ya'axché Conservation Trust and a scientist's

child helicoptered into the reserve to spend one month collecting data (Figure 8). The archaeologists on the team have been going to the Bladen since the 1990's and established a base camp in front of a cave (affectionately nicknamed AC cave), which provides cool air in the tropical forest. The guides built the camp in a day, our table and benches made of *Geonoma interrupta* stems and the latrine walls built with overlapping *Attalea cohune* leaves, we were ready to get to work.

The ancient Maya had fields of shifting successional crops and cultivated trees, and planted a wide range of home gardens, often intermixed (Fedick 2024). The remains of Maya polyculture are abundant in the Bladen. Cacao (chocolate tree, *Theobroma cacao*) was an important part of Maya diets and culture (Fedick 2021); therefore, cacao is a focal species of the project. Cacao is understood to have originated in South America; however, the



3 (top). *Bactris mexicana* produces colorful infructescences when laden with ripe fruit, bringing vibrant color to the forest during the dry season. 4 (bottom). *Chamaedorea neuroclamys* is one of six species in genus found in the Bladen. Photos: Steven Brewer.



5. *Desmoncus chinantlensis* is distributed from southern Mexico to Guatemala. Photo: Christine Bacon.



6. *Geonoma interrupta* subsp. *magnifica*, one of three subspecies. This subspecies is unique in its numerous pinnae and Central American distribution (Henderson 2011). Photo: Steven Brewer.

domestication of the species has been particularly well documented in Central America, in part due to the tree's cultural significance to the Maya (Lanaud et al. 2024).

Maya forest gardens were rich in palms, including *Acrocomia aculeata*, *Attalea cohune*, *Chamaedorea* species, *Cryosophila stauracantha* and *Sabal mauritiiformis* (Ford 2022). *Acrocomia aculeata* is a fascinating species that is considered to be incipiently domesticated in a review by Clement (1999). It is hypothesized to have been introduced from South America into Central America in pre-Columbian times (Morcote-Ríos & Bernal 2001). The species is also found to be strongly associated with anthropogenic soils in Amazonia (Junqueira et al. 2010). The species was an important source for oil and fruit for early Amazonian people and there is great interest in its exploitation for biofuel production and oil (de Lima et al. 2018). While not documented in the Bladen Nature Reserve, it is found in the adjacent Chiquibul Forest (Bridgewater et al. 2006a) and provides many interesting research questions regarding human legacy for future exploration.

One of the most common species in the Bladen is *Calypatrogyne ghiesbreghtiana* (Back Cover). This species forms a dense and dominant ground cover. Yet, this species is rare outside of the upper Bladen and Southern Toledo district (Brewer, personal observation). The cause of this interesting spatial pattern may be related to its adaptation to intense shade conditions (Alvarez-Clare & Avalos 2007) and in Belize it inhabits the areas of highest rainfall with the highest canopies.

Attalea cohune is the second target of the BLADEN project. The species thrives under human disturbance and is common in anthropogenic settings all along the Caribbean coast (e.g. Johannessen 1957). A survey of the species in Belize indicated that not only has *A. cohune*-rich forest been preferentially cleared for modern agriculture historically, but abundance of the species also results from its intentional management in agricultural systems (McSweeney 1995). Palms are often spared during land clearing for pasture, as they provide shade for animals but also since *A. cohune* stems are covered in thick, persistent leaf sheaths, they are difficult to cut and are



7. *Sabal mauritiiformis* is the most common of the three species in the genus distributed in Belize. Photo: Christine Bacon.

resistant to burning. In addition, even when land is cleared and then burned, *Attalea* species can persist since the meristematic shoot apex remains underground for up to ten years, protecting individuals (McSweeney 1995). *Attalea cohune* was and remains one of the most important tree crops cultivated by the Maya. The leaves are used for thatch, the seeds are high in edible oils, the endocarps make good compost, the hearts can contain up to 15 kg of edible carbohydrate rich in protein and the trunks are useful for cultivating honeybees (Fedick 2021).

Interestingly, in a study of the plant diversity in the Bladen Nature Reserve, Iremonger et al. (1995) note that the culturally important *A. cohune* is not evenly distributed. *Attalea cohune* either forms monotypic stands with relatively

low species diversity in the subcanopy, or the species is totally absent. *Attalea cohune* forests do not differ in soil fertility than forests without this species, but do present structural differences (Eshleman & Beach 2020). The species was and today remains an integral resource for the Maya, providing roofing thatch and calorically dense food and oil, and its distribution and abundance likely reflects a legacy of human activity.

To understand human legacy on plants, our project will develop genome references for our target species. Then we will use DNA sequences from contemporary individuals that we sampled to determine population diversity and structure. We can then exploit mathematical models to trace population size through time, to test for demographic changes in response to Maya colonization of the area, through the height of the Maya Classic period and post societal collapse. With these same goals of understanding change through time, we will also sequence DNA from sediments to determine plant community turnover. We will then compare and contrast our results, as well as with data from plant pollen and phytoliths, to build a model of forest change through time. Integration and interpretation of results will inform ecosystem recovery following disturbance and ideally the development of informed conservation strategies for the future security of some of the planet's most biodiverse ecosystems.

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LITERATURE CITED

- ALVAREZ-CLARE, S. AND AVALOS, G. 2007. Light interception efficiency of the understory palm *Calyptrogyne ghiesbreghtiana* under deep shade conditions. *Ecotropica* 13: 57–65.
- BREWER, S.W. 1996. The palms of Belize: species richness and a key based on vegetative characters. *Palms* 43: 109–113.
- BREWER, S.W. AND WEBB, M.A.H. 2002. A seasonal evergreen forest in Belize: unusually high tree species richness for northern Central America. *Botanical Journal of the Linnean Society* 138: 275–296.
- BRIDGEWATER, S.G.M. ET AL. 2006a. A preliminary checklist of the vascular plants of the

- Chiquibul Forest, Belize. *Edinburgh Journal of Botany* 63: 269–321.
- BRIDGEWATER, S.G.M. ET AL. 2006b. *Chamaedorea* (*Xaté*) in the Greater Maya Mountains and the Chiquibul Forest Reserve, Belize: an economic assessment of a non-timber forest product. *Economic Botany* 60: 265–283.
- BRIDGEWATER, S.G.M., GARWOOD, N.C. AND BREWER, S. 2007. Common palms of Belize. Field Museum Field Guide. https://fieldguides.fieldmuseum.org/sites/default/files/rapid-color-guides-pdfs/404_1.pdf.
- CALONJE, M., MEEROW, A.W., MEERMAN, J., FRANCISCO-ORTEGA, J. AND GRIFFITH, M.P. 2024. Population genetics of *Zamia decumbens* (Zamiaceae, Cycadales), an endangered cycad from the Maya Mountains of Belize. *Plant Species Biology X*: 1–17.
- CÁMARA-LERET, R., FORTUNA, M.A. AND BASCOMPTE, J. 2019. Indigenous knowledge networks in the face of global change. *Proceedings of the National Academy of Science U.S.A.* 116: 9913–9918.
- CIBRIÁN-JARAMILLO, A. ET AL. 2009. Population genetics of the understory fishtail palm *Chamaedorea ernesti-augusti* in Belize: high genetic connectivity with local differentiation. *BMC Genetics* 10: e65.
- CLEMENT, C.R. 1999. 1492 and the loss of Amazonian crop genetic resources. I. The relation between domestication and human population decline. *Economic Botany*. 53: 188–202.
- COELHO, S.D. ET AL. 2021. Eighty-four per cent of all Amazonian arboreal plant individuals are useful to humans. *PLOS One* 16: e0257875.
- DE LIMA, N.E., ASSIS CARVALHO, A., MEEROW, A.W. AND MANFRIN, M.H. 2018. A review of the palm genus *Acrocomia*: Neotropical green gold. *Organisms Diversity & Evolution* 18: 151–161.
- ELLIS, E.C. ET AL. 2021. People have shaped most of terrestrial nature for at least 12,000 years. *Proceedings of the National Academy of Science U.S.A.* 118: 1–8.

8. The BLADEN project team, Citali (Alex) Tierney, Christopher Ploetz, Wilmer Mes, Jose Mes, Mark Robinson, Nadia Neff, Sara Eschleman, Roberto Tzib, Esteban Rangel, Mia Romero, Amy Thompson, Marlon Coc, Silvestre Rash (back standing, left to right), Oligario Sho, Keith Prufer, Christine Bacon (front, seated). Photo: Keith Prufer.



- ESCHELMAN, S. AND BEACH, T. 2020. Soil fertility of cohune palm (*Attalea cohune*) dominant forests compared to non-cohune forests in northwestern Belize. *Plant Soil* 452: 295–311.
- FEDICK, S.L. 2021. Maya Cornucopia: Indigenous Food Plants of the Maya Lowlands. Pp. 224–237, in MASSON, M.A., FREIDEL, D.A. AND DEMAREST A.A. (eds.). *The Real Business of Ancient Maya Economies: From Farmers' Fields to Rulers' Realms*. Gainesville, USA.
- FEDICK, S.L., MORELL-HART, S. AND DUSSOL, L. 2024. Agriculture in the ancient Maya Lowlands (Part 2): Landesque capital and long-term resource management strategies. *Journal of Archaeological Research* 32: 103–154.
- FORD, A. 2022. Scrutinizing the paleoecological record of the Maya forest. *Frontiers in Ecology and Evolution*: 10: e868660.
- HENDERSON, A.J. 2011. A revision of *Geonoma* (Arecaceae). *Phytotaxa* 17: 1–271.
- HENDERSON, A., GALEANO, G. AND BERNAL, R. 1995. *Field Guide to the Palms of the Americas*. Princeton University Press, Princeton, USA
- IREMONGER, S., LIESNER R. AND SAYRE, S. 1995. Plant records from natural forest communities in the Bladen Nature Reserve, Maya Mountains, Belize. *Caribbean Journal of Science* 31: 30–48.
- JOHANNESSEN, C.L. 1957. Man's role in the distribution of the corozo palm (*Orbignya* spp.) Yearbook of the Association of Pacific Coast Geographers 19: 29–33.
- JUNQUEIRA, A.B., SHEPARD JR., G.H. AND CLEMENT, C.R. 2010. Secondary forests on anthropogenic soils in Brazilian Amazonia conserve agrobiodiversity. *Biodiversity and Conservation* 19: 1933–1961.
- LANAUD, C. ET AL. 2024. A revisited history of cacao domestication in pre-Columbian times revealed by archaeogenomic approaches. *Scientific Reports* 14: e2972.
- LEVIS, C. ET AL. 2017. Persistent effects of pre-Columbian plant domestication on Amazonian forest composition. *Science* 355: 925–931.
- McSWEENEY, K. 1995. The Cohune palm (*Orbignya cohune*, Arecaceae) in Belize: a survey of uses. *Economic Botany* 49: 162–171.
- MORCOTE-RÍOS, G. AND BERNAL, R. 2001. Remains of palms (Palmae) at archaeological sites in the New World: a review. *The Botanical Review*. 67: 309–350.
- MORCOTE-RÍOS, G., ACEITUNO, F.J., IRIARTE, J., ROBINSON, M. AND CHAPARRO-CÁRDENAS, J.L. 2021. Colonization and early peopling of the Colombian Amazon during the Late Pleistocene and the Early Holocene: new evidence from La Serranía La Lindosa. *Quaternary International* 578: 5–19.
- PRUFER, K.M. 2005. The Early Classic in southern Belize: a regional view from Uxbenká and Ek Xux. *Research Reports in Belizean Archaeology* 2:169–178.
- PRUFER, K.M., ROBINSON, M. AND KENNETT, D.J. 2021. Terminal Pleistocene through Middle Holocene occupations in southeastern Mesoamerica: linking ecology and culture in the context of Neotropical foragers and early farmers. *Ancient Mesoamerica* 32: 439–460.
- ROBINSON, M., MORCOTE-RÍOS, G., ACEITUNO, F.J., ROBERTS, P., BERRÍO, J.C. AND IRIARTE, J. 2021. 'Moving South': Late Pleistocene plant exploitation and the importance of palms in the Colombian Amazon. *Quaternary* 4: e26.
- WALLACE, A.R. 1853. *Palm Trees of the Amazon and Their Uses*. Taylor and Francis, London, UK.

Sabal tamaulipensis, a New Species from Northeastern Mexico

AYRESS D. GRINAGE^{1*}, KEILY A. PERALTA¹ AND MARÍA MAGDALENA SALINAS-RODRÍGUEZ²

We describe populations of *Sabal* from northeastern Mexico as a new species, *S. tamaulipensis*. Molecular data indicate *S. tamaulipensis* is monophyletic and sister to *S. minor*. *Sabal tamaulipensis* is distinguished from *S. minor* by its larger fruit and seed size, and inflorescence equaling or shorter than the height of the leaves. *Sabal tamaulipensis* occurs in subtropical submontane scrub, a distinct habitat from the floodplain habitat of *S. minor*. The recognition of all populations from the Mexican states of Tamaulipas and Nuevo León as a separate species now confines the native range of *S. minor* to the southern United States.

Sabal Adans. (Coryphoideae: Arecaceae) is a New World genus native to the southeastern United States, Central America, northern South America and the Caribbean. There are approximately 19 species of *Sabal* (Griffith et

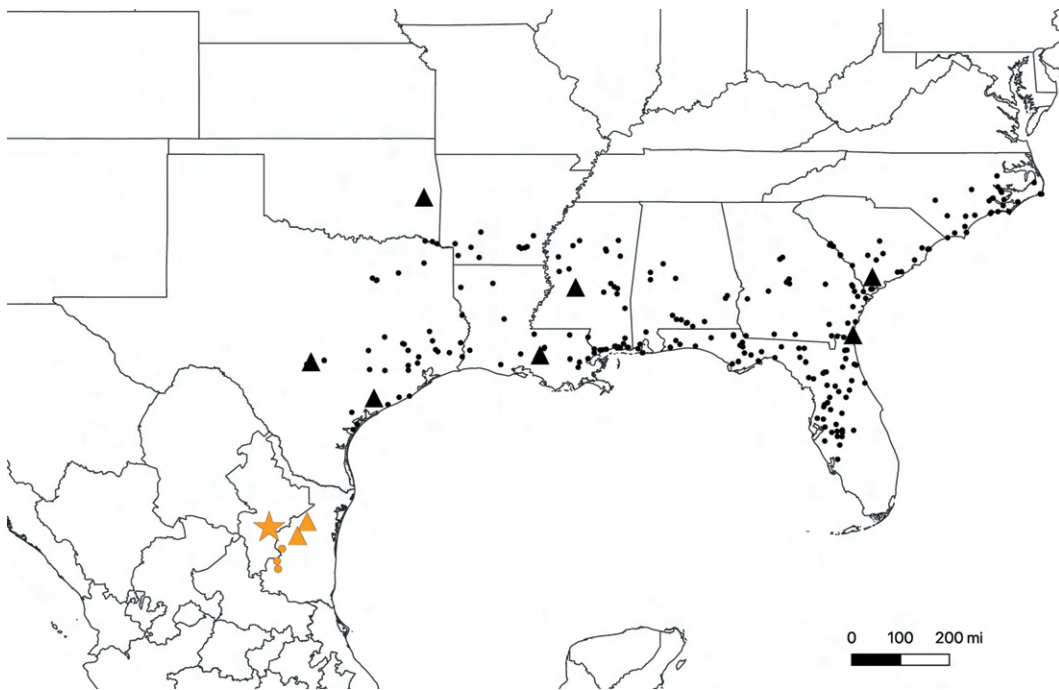
al. 2021), all of which are characterized, in part, by unarmed, costapalmate leaves with a triangular split at the base of the leaves (Zona 1990). Seeds are readily discernible by a distal circular opercular scar (Manchester et al. 2010). Well over one-third of the species of *Sabal* are distributed in Mexico alone. Two species of *Sabal* are currently known from the Mexican northeastern states of Tamaulipas and Nuevo León, *S. mexicana* Mart. and *S. minor* (Jacq.) Pers.

The natural range of *S. mexicana* has been described to be from very extreme southern Texas, along the Gulf coast of Mexico down to the Yucatan peninsula (Zona 1990). *Sabal minor* ranges across the southeastern United States (Fig. 1) from the Atlantic Coast of North

¹Cornell University, Ecology and Evolutionary Biology and the L.H. Bailey Hortorium, Ithaca, NY, USA.

²Herbario UNL, Facultad de Ciencias Biológicas de la Universidad Autónoma de Nuevo León, México. Av. Pedro de Alba, Niños Héroes, Ciudad Universitaria, C. P. 66455, San Nicolás de los Garza, N.L., México.

*author for correspondence

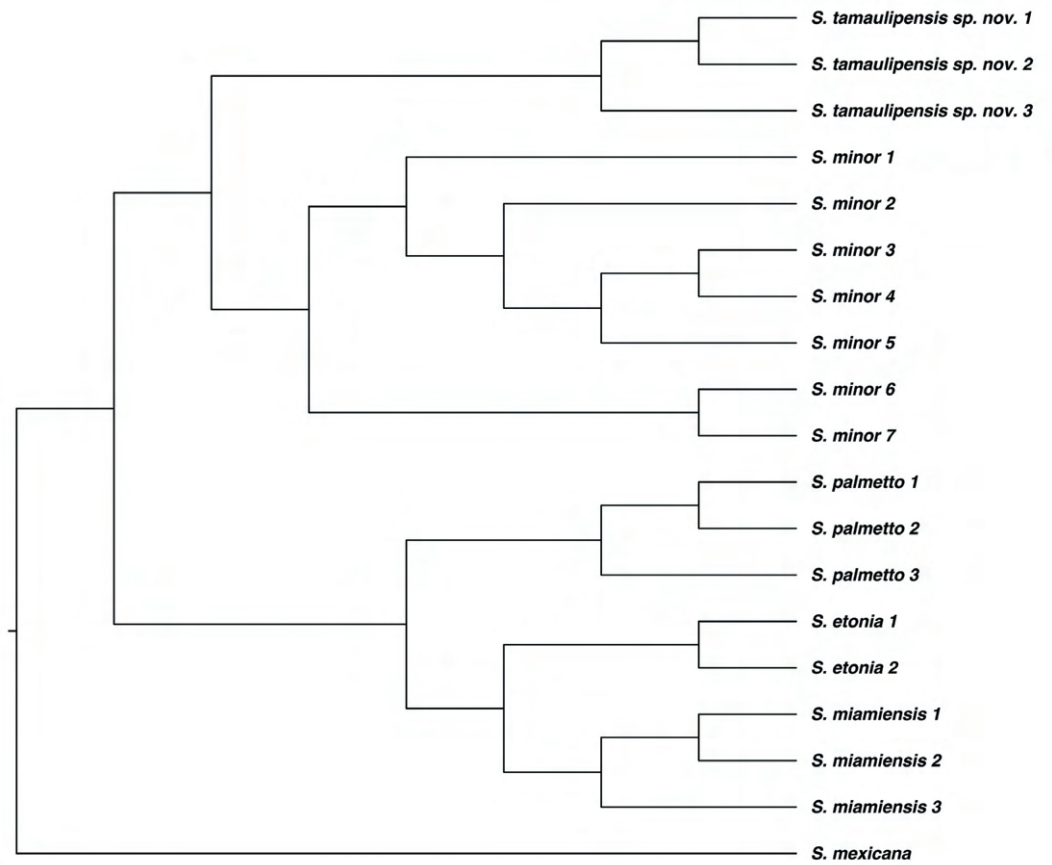


1. Distribution of *Sabal tamaulipensis*. Map shows *Sabal tamaulipensis* occurrences (orange), orange star indicates the location of the type specimen, Goldman 900. The distribution of *S. minor* (black) is also shown to illustrate the disjunction between the southernmost range of *S. minor* in Texas and the distribution of *S. tamaulipensis*. Circles designate occurrence data downloaded from iNaturalist and/or the Global Biodiversity Information Facility (GBIF: <https://www.gbif.org/>); GBIF occurrences downloaded 8 January 2025 and available at <https://doi.org/10.15468/dl.qrdmcy>. Note, some occurrences removed for illustrative purposes. Triangles designate sequenced accessions shown in the phylogeny (Figure 2).

Carolina and Florida to its most southern range along the central Gulf coast around Corpus Christi, Texas (Zona 1990). In 1999, the range of *S. minor* was extended into northeastern Mexico based on populations collected by Goldman (Goldman 900 at MEXU) in Nuevo León. Plants collected from this area were assigned to *S. minor* based on field observations and comparison with herbarium specimens of *S. minor* from the USA, specimens of *S. mexicana* found along the Texan and Mexican Gulf coast, and specimens of other acaulescent palms growing in the area (Goldman 1999). However, the nearest population of *S. minor* is over 200 km away (Fig. 1) and in addition, the habitat of the plants collected in Mexico is completely different from the usual range of *S. minor*. While *S. minor* is usually found in river swamps or floodplain forest, the plants collected in Mexico reside in a dry subtropical upland forest (Goldman 1999). Over a decade later, Goldman 900 from the Mexican (Nuevo León) population of *S. minor* was included in a genetic study focused on evaluating the ancestry of a putative *Sabal* hybrid from the coastal plain in eastern Texas (*S. × brazoriensis*

D.H.Goldman, Lockett & Read). The Mexican individual did not fall into a clade with the remaining 12 samples of *S. minor* from the US (Goldman et al. 2011, their Figure 1), rather the Mexican individual was separated from the clade of *S. minor* from the US by the material from Brazoria. Since only one sample from Mexico was included in the study, the taxonomy of the Mexican “*S. minor*” material was considered an open-ended question.

In the process of generating Restriction-site Associated DNA Sequencing (RAD-seq) data to analyze population-level genetic and phylogeographic patterns of *S. minor*, Grinage et al. (in prep) found a notable result on the Mexican samples. Using three silica-dried samples of cultivated Mexican material from Tamaulipas, Mexico (Table 1). Grinage et al. (in prep) generated genomic sequencing using the restriction enzyme *apek1* to cut genomic DNA at restriction sites, resulting in millions of short DNA fragments that were then sequenced. Sequenced DNA fragments were mapped to a reference genome of *S. minor* to identify single nucleotide polymorphisms,



2. Schematic phylogenetic tree based on RAD-seq data showing that *S. tamaulipensis* is monophyletic and sister to *S. minor*. Tree was generated using SVDquartets in PAUP*.

Table 1. Summary of accessions included in the phylogenetic tree in Figure 2.

Phylogeny Tip	Collection Number/ Garden ID	Herbarium/ Botanical Garden	Latitude	Longitude
<i>S. tamaulipensis</i> sp. nov. 1	Grinage 28	FLAS	24.9430461	-98.6445869
<i>S. tamaulipensis</i> sp. nov. 2	Grinage 254	BH	24.9430461	-98.6445869
<i>S. tamaulipensis</i> sp. nov. 3	Grinage 255	BH	24.497791	-98.9461096
<i>S. minor</i> 1	Majure 7199	FLAS	32.3103284	-90.1937874
<i>S. minor</i> 2	Bailey 731	BH	30.1811813	-91.3175833
<i>S. minor</i> 3	Bomhard s.n. Lolita	BH	28.833362	-96.539224
<i>S. minor</i> 4	Kendalia	JLBG	29.9691019	-98.5222441
<i>S. minor</i> 5	Goldman 459	BH	35.1495634	-94.967097
<i>S. minor</i> 6	Bailey 117	BH	32.6409925	-80.8571818
<i>S. minor</i> 7	Goldman 549	BH	30.8128925	-81.4662768
<i>S. palmetto</i> 1	20050634C	MBC	29.78083	-85.40608
<i>S. palmetto</i> 2	20020899D	MBC	25.45238	-76.70026
<i>S. palmetto</i> 3	20050677B	MBC	30.48491	-81.49833
<i>S. etonia</i> 1	20050716A	MBC	27.706	-81.4428
<i>S. etonia</i> 2	20050694A	MBC	29.20533	-82.04163
<i>S. miamiensis</i> 1	948G	MBC	26.455	-80.05965
<i>S. miamiensis</i> 2	86513J	MBC	25.97315	-80.18277
<i>S. miamiensis</i> 3	85299A	MBC	25.9426	-80.15441
<i>S. mexicana</i>	Zona 181	FLAS	17.0812981	-96.7357315



3. Overall morphology of *Sabal tamaulipensis*. (A) Photo shows the shorter length of the inflorescence with respect to the length of the leaves. (B) Erect infructescence with shortened internodes resulting in densely clustered fruit. (C) Side view of leaf showing blade curvature due to costa. (D) Fruit, on ¼ inch grid squares. (E) Opening flower bud. (F) Seeds, on ¼ inch grid squares.

SNPs (variable DNA sites among samples). Filtered SNPs were used to generate a phylogeny reconstructed using SVDquartets in PAUP* (Swofford 2003, v. 4A build 168).

Reproduced with a smaller sample size in the present manuscript, we show that the Mexican samples are genetically distinct from US material of *S. minor* (Fig. 2), corroborating the results of Goldman et al. (2011). These samples resolve as a monophyletic group that is sister to *S. minor* samples from the US (Fig. 2). Here, we describe the Mexican material previously designated as *S. minor* as a new species, *S. tamaulipensis*, from Tamaulipas and Nuevo León, Mexico.

Taxonomic treatment

***Sabal tamaulipensis* Grinage, sp. nov.** Type: MEXICO. Nuevo León, 26 km west of Linares, along Mexican Route 60, *Goldman 900* (holotype MEXU, photos at BH, K, TEX).

Diagnosis: *Sabal tamaulipensis* is morphologically most similar to *S. minor*; however, *S. tamaulipensis* can be distinguished from *S. minor* via reproductive and vegetative characters. The costa of the leaf is longer in *S. tamaulipensis* (*S. tamaulipensis* = 15–28.5 cm vs *S. minor* = 1.3–16.7 cm). Additionally, the inflorescences in *S. tamaulipensis* have shorter internodes giving it a bushier and denser appearance and its height can be shorter to or equal to the height of the rest of the leaves. Lastly, the fruit of *S. tamaulipensis* (12–15 mm wide, 10–12 mm long) are larger than the fruit of *S. minor* (7.1–10.8 mm wide, 7.5–10.4 mm long).

Solitary palm 198–244 cm tall, stem short, compact, subterranean, sometimes oriented horizontally along soil. **Leaves** 177–261 cm long, emerging from the soil, moderately costapalmate; petiole 48.2–159.5 cm long, glabrescent; hastula 4–4.7 cm long, 1.3–2.5 cm wide, acute, glabrescent, slightly involute; costa extending into the blade for 15–28.5 cm, glabrescent; segments 38–49, apical leaf segments split up to 30% of the total segment length shorter than basal segments. **Inflorescence** 58–234 cm long, erect, shorter or equal to the length of the leaves, branched to 2 or 3 orders. **Flower** 4.2–6.0 mm long, born singly, sessile, bisexual, radially symmetric; sepals 1.9–2.6 mm long, 0.3–2 mm wide, cupulate; petals 3.1–4.8 mm long, 1.3–1.5 mm wide, obovate to ovate, white, membranous; stamens 4.3–5.4 mm long, ascending, adnate to the corolla, anther 1.3–1.5 mm long and

0.5–1 mm wide; gynoecium 3.5–4.2 mm long, ovary 1.1–1.3 mm diameter, 1.3–1.7 mm long. **Fruit** oblate spheroidal to spherical, 12–15 mm diameter, 10–12 mm long, glabrous, brown-black, mesocarp 0.5–1 mm thick. **Seed** oblate spheroidal to spherical, 9–12 mm diameter, 4–7 mm long, brown, glabrous.

Distribution: *Sabal tamaulipensis* is distributed between two Mexican states, Nuevo León and Tamaulipas, along the eastern edge of the Sierra Madre Oriental mountain range.

Habitat: *Sabal tamaulipensis* occurs in submontane scrub (Rzedowski 1978), an ecosystem distributed on the windward slopes at the foot of the Sierra Madre Oriental forming an ecotonal strip between the Tamaulipan thorn scrub of the Gulf Coastal Plain and the oak forests of the higher elevations of the area (Salinas et al. 2013). In general, the scrub habitat occurs on shallow limestone soils. Climate in this region varies between warm and semi-warm climates with precipitation typically ranging from 450 to 900 mm a year (García 1998). The most representative species of the submontane scrub include: *Senegalia berlandieri*, *Erythrostemon mexicanus*, *Malacomeles denticulata*, *Chilopsis linearis*, *Quercus polymorpha*, *Helietta parvifolia*, *Ungnadia speciosa*, *Cordia boissieri*, *Fraxinus greggii*, *Colubrina greggii*, *Casimiroa pringlei* and *Decatropis bicolor*. Before the rainy season (March–July) many plants are in bloom, while during the rainy season (August–November), fruiting occurs; this phenological pattern appears to also occur in *S. tamaulipensis*.

Vernacular Names: Tamaulipas palmetto, Mexican scrub palm

Etymology: The name refers to one of the Mexican states (Tamaulipas, Mexico), to which the species is native. This name links the new species to the horticulturally used name of '*Sabal* sp. Tamaulipas' which was introduced to the horticultural trade following its collection in 1988 from Villa Mainero (Tamaulipas, Mexico).

Additional Specimens Examined: *Sabal tamaulipensis*: MEXICO. Nuevo León: 15.2 miles W of Linares in Santa Rosa Canyon, 8 November 2001, *Hodel 1904* (BH!). Tamaulipas: 4.7 miles SW of Villa Mainero where road first runs along river, 8 November 2001, *Hodel 1905* (BH!); 17.8 miles W of Hacienda Estacion Engracia on dirt road into Rio Purificacion drainage, 9 November 2001, *Hodel 1910* (BH!). CULTIVATED. UNITED STATES. North



4. Comparison of leaves. From left to right, *S. minor*, *S. × brazoriensis* and *S. tamaulipensis*.

Carolina: Wake County, Raleigh, Juniper Level Botanic Garden, 35.626389, -78.638611, 19 August 2023, *Grinage* 253 (BH!), *Grinage* 254 (BH!), *Grinage* 255 (BH!); Florida: Baker County, 30.29820, -82.16348, 18 December 2018, *Grinage* 28 (FLAS!).

Sabal minor: UNITED STATES. South Carolina: Georgetown County, Hobcaw Barony, 1 mile N of Georgetown on US 17, W end of King's Hwy at Frasier's Point on Winyah Bay, 31 March 1984, *Mengak* 114 (CLEMS!); Berkeley County, Francis Marion National Forest, approximately 0.5 mi to W of the intersection of Forest Service Roads 124 and 121, 16 March 1996, *Townsend* 713 (CLEMS!). Florida: Lake County, in vicinity of Eustis, 16-31 May 1894 *Nash s.n.* (DOV!); Walton County, Eglin Air Force Reservation, circa 1 mi N of junction, Florida 20, along No. 500, circa 2.5 miles northeast of Portland, 27 September 1967, *Smith* 2025 (LSU!). Mississippi: Jackson County, Moss Point, Pascagoula River, island just south of Interstate 10 (cactus island), 30.42093, -88.56694, 2 August 2018, *Majure* 7148 (FLAS!); Harrison County, Biloxi River off of Cedar Lake Road, just east of Interstate 10, 30.45849, -88.94211, 11 April 2019, *Majure* 7686 (FLAS!); Newton County, near Sebastopol, 10 June 2002, *Estes and Maddox* 03405 (APSC!). Louisiana: Morehouse Parish, Bonita Swamp near Jones, Section 6, T 22 N, R 8 E, 15 June 1973, *Thompson* 159 (BEREA!). Texas: Hardin County, Village Creek State Park, east edge of Lumberton, Water Oak Trail between Sandy

Slough and Caney Slough, 30.25, -94.166667, 23 October 2003, *Sanders* 6326 (BRIT!).

Discussion

For decades *Sabal tamaulipensis* was a part of *S. minor* due to the morphological similarities between the two; both are acaulescent, weakly to moderately costapalmate and bear erect inflorescences. However, molecular data from *S. tamaulipensis* and *S. minor* indicated that these could be separate species (Goldman et al. 2011) with recent data showing that specimens collected in Mexico form a clade distinct from and sister to *S. minor* (Fig. 2). Given the DNA evidence, morphological distinctiveness, habitat difference, and well over 200 miles between *S. tamaulipensis* and the closest populations of *S. minor* we choose to designate *S. tamaulipensis* as a distinct species.

Although young individuals of both *S. tamaulipensis* and *S. minor* appear to have a similar flattened leaf shape, the leaves of *S. tamaulipensis* become curved in profile due to a longer extension of the costa into the leaf blade (Fig. 3C). The reproductive morphology of *S. tamaulipensis* is also distinct from *S. minor*. The inflorescence in *S. tamaulipensis* is typically shorter to or equal the height of the leaves (Fig. 3A, 3B); however, in *S. minor* the inflorescence often exceeds the height of the leaves. Furthermore, the inflorescence in *S. tamaulipensis* has shorter internodes which gives the inflorescence an overall bushy and

dense appearance (Fig. 3B). On the other hand, *S. minor* has longer internodes giving it a thin, sparse appearance (Zona 1990).

When we first observed *S. tamaulipensis* (Grinage pers observ.), the leaves appeared to differ from *S. minor* mostly quantitatively with *S. tamaulipensis* exhibiting larger leaves and considerably thicker petioles (Fig. 4). *Sabal minor* is known to be highly morphologically variable, e.g., the Blountstown Dwarf (Zona 1990) or the trunk bearing populations along the US Gulf Coast previously described as *S. louisiana* (Bomhard 1943, Bailey 1944, Ramp & Thien 1995). However, even with this noted variation in *S. minor*, for instance of the costa length, the overall trend is smaller in *S. minor* (costa length: 1.3–16.7 cm) and larger in *S. tamaulipensis* (15–28.5 cm). Consistent with this trend, *S. tamaulipensis* also bears larger fruit (12–15 mm diameter 10–12 mm height vs *S. minor*: 7.1–10.8 mm diameter, 7.5–10.4 mm height) and larger seeds (9–12 mm diameter, 4–7 mm height vs *S. minor*: 4–7 mm diameter, 3–5 mm).

The molecular data indicate *S. tamaulipensis* is monophyletic and sister to *S. minor* (Fig. 2). Additionally, given the geographic location, it is unlikely that *S. tamaulipensis* is a hybrid taxon (Fig. 1). *Sabal minor* is well over 100 miles away from *S. tamaulipensis* and *S. mexicana*, the latter being the only other likely putative parent. Given that *S. minor* and *S. mexicana* are not sympatric, pollen would have had to travel a great distance in order for a hybrid to form. Considering that pollen loses viability as distance increases (Read 1979), it seems unlikely that *S. tamaulipensis* is the product of hybridization between *S. minor* and *S. mexicana*. Consistent with this perspective, Goldman et al. 2011 found that *S. tamaulipensis* (designated as *S. minor* from Mexico) does not behave like a hybrid as was found for the proposed hybrid *S. × brazoriensis*. Recognition of *S. tamaulipensis* as a new species effectively confines the southernmost distribution of *S. minor* along its western edge around Copano Bay, Texas.

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LITERATURE CITED

- BAILEY, L.H. 1944. Revision of the palmettoes. *Gentes Herbarum* 6: 365–459.
- BOMHARD, M.L. 1943. Distribution and character of *Sabal louisiana*. *Journal of the Washington Academy of Sciences* 33: 170–182.
- GARCÍA, E. 1998. Mapa de Climas de México, Escala 1: 1000000. Comisión Nacional para el conocimiento y uso de la biodiversidad (CONABIO), México.
- GOLDMAN, D.H. 1999. Distribution update: *Sabal minor* in Mexico. *Palms* 43: 40–44.
- GOLDMAN, D.H., KLOOSTER, M. R., GRIFFITH, M.P., FAY, M.F. AND CHASE, M.W. 2011. A preliminary evaluation of the ancestry of a putative *Sabal* hybrid (Arecaceae: Coryphoideae), and the description of a new nothospecies, *Sabal × brazoriensis*. *Phytotaxa* 27: 8–25.
- GRIFFITH, M.P., MEYER, A. AND GRINAGE, A. 2021. Global *ex situ* conservation of palms: living treasures for the botanic garden. *Frontiers in Forests and Global Change* 4: 711414.
- MANCHESTER, S.R., LEHMAN, T.M. AND WHEELER, E.A. 2010. Fossil palms (Arecaceae, Coryphoideae) associated with juvenile herbivorous dinosaurs in the upper Cretaceous Aguja formation, Big Bend National Park, Texas. *International Journal of Plant Sciences* 171: 679–689.
- RAMP, P.F. AND THIEN, L.B. 1995. A taxonomic history and reexamination of *Sabal minor* in the Mississippi Valley. *Principes* 39: 77–83.

- READ, R.W. 1979. Live storage of palm pollen. *Principes* 23: 33–35.
- RZEDOWSKI, J. 1978. *Vegetación de México*. Editorial Limusa, México.
- SALINAS-RODRÍGUEZ, M.M., ESTRADA-CASTILLÓN, E. AND VILLARREAL-QUINTANILLA, J.Á. 2013. Flora and phytogeography of the cañón de Iturbide, Nuevo León, Mexico. *Journal of the Botanical Research Institute of Texas* 7: 803–819.
- SWOFFORD, D.L. 2003. PAUP*. Phylogenetic Analysis Using Parsimony (*and Other Methods). Sinauer Associates, Sunderland, Massachusetts. Version v. 4A build 168.
- ZONA, S. 1990. A monograph of *Sabal* (Arecaceae: Coryphoideae). *Aliso* 12: 583–666.
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Gregório Bondar

ANDREW HENDERSON¹

This article gives a brief outline of the extraordinary life of the eminent Brazilian botanist and entomologist, Gregório Bondar.

Bondar is known to palm botanists for his work on the eastern Brazilian species of *Attalea* and *Syagrus*. However, he was more of an entomologist than a botanist and described hundreds of new species of insect, many of them associated with palms. But beyond his scientific work, Bondar led an extraordinary life. Most of what is known of this was written by Bondar himself in an article in Portuguese published in a somewhat obscure Brazilian entomology journal (Bondar 1943). This article was abridged and translated by his daughter and published as part of an obituary after he died in 1959 (Moore 1960). More information on Bondar's life was later published by Silva Filho & Nomura (1981) and Garcez (1981).

Gregório Gregorievitch Bondar was born in 1881 in the village of Mala Burimka (then known by its Russian name of Malaia Buromca) in the central part of Ukraine, about 200 km southeast of Kyiv. His family moved to the "*terras devolutas*" (vacant lands) of central Siberia when he was 13 years old. He continued his education there and, from 1902 to 1905, was a primary school teacher.

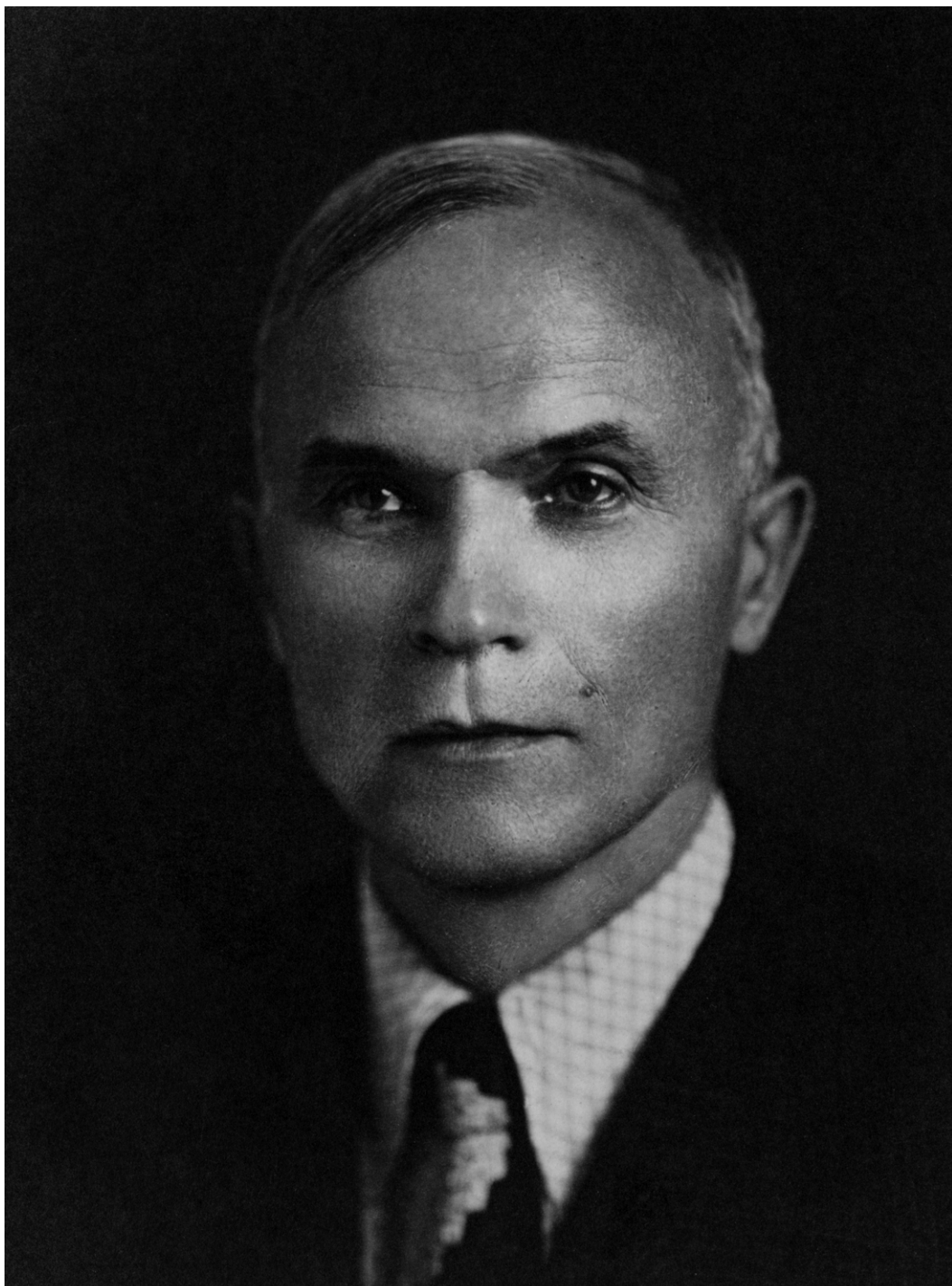
The early years of the twentieth century were a tumultuous time in Russia. The Russo-

Japanese war of 1904–1905 left Russia defeated and demoralized. Political and social unrest led to the first Russian Revolution of 1905. Unrest continued up to the outbreak of World War I in 1914. The October Revolution of 1917 was the opening shot in the ultimate victory of the Bolsheviks over the White Russians and the end of the civil war in 1922.

Bondar's life was greatly affected by these events. In 1905, at the age of 24, he was called up for military service in the Russo-Japanese war. That same year he was imprisoned for distributing subversive political propaganda. He was granted amnesty but was arrested again for taking part in an armed uprising. He escaped in 1906 and travelled to Manchuria in China under an assumed name, where he taught in the Russian School of Commerce. Forced to leave China in 1907, he travelled to Japan and then eventually to France. In 1908 he enrolled in the Agronomy Institute of the University of Nancy and received his diploma in 1910. From France, Bondar travelled to Brazil, arriving in Santos, Bahia in 1910. In 1911 he got a position at the Agronomy Institute in Campinas, São Paulo, and in 1913 moved to the Escola Superior in Piracicaba, São Paulo, where he was a teacher of agricultural zoology and entomology. That same year he became a Brazilian citizen.

The most extraordinary decision Bondar made was to return to Russia in 1916. This was at

¹Center for Biodiversity & Evolution,
New York Botanical Garden
Bronx, NY 10458 USA



1. Gregório Bondar

the height of World War I and at the beginning of the Russian Revolution. Bondar travelled back to Russia via England, Norway, Sweden, and Finland. After some military training he was arrested again for the same 1905 charges. He was sent to prison in Siberia but was again

freed due to an amnesty. He stayed in Siberia for two years, working on political and scientific projects, including becoming deputy governor of the Department of Jenisseisk. At some time during these years he married an Italian woman, Olga Pannoni and had a



Fig. 33. Piaçaveira, *Orbignya eichleri*. Caxias, Maranhão. (Piaçava palm.)

2. *Orbignya eichleri* (now *Attalea eichleri*), from *Palmeiras do Brasil* (Bondar 1964).

daughter, Jacy. After the communists took over he was again arrested and, in December 1919, was sentenced to death by the local executive committee. While held in prison in Irkutsk, he was placed on a list of 100 people to be executed. Bondar was saved by his agronomic experience. He was taken off the list on condition that he help overcome a locust outbreak that was devastating the wheat fields of the south of the province.

On his way to the wheat fields he again managed to escape and made his way back to Brazil by way of Mongolia, Manchuria, Korea and Japan. He arrived back in the port of Santos in December 1920. The lush tropical forest of Bahia must have seemed a paradise compared to the cold, bleak tundra of Siberia. He devoted the remaining 40 years of his life to botany and entomology, working at various research institutes in Bahia. To the best of my knowledge, Bondar left Brazil only once again, to attend a scientific conference in Washington in 1940. There he presented a paper entitled "The entomology of the flowers of palms."

From a taxonomic point of view, Bondar's contribution was modest. He described only 26 species of palm (12 of them hybrids), 10 of which are still recognized. After his death, the

Instituto de Botânica in São Paulo published his *Palmeiras do Brasil* (Bondar 1964), a work that he had submitted for publication before his death and one that summarized his life's work on palms (Figs. 2–5). Much more important was his work on economic botany and insects of palms. He published papers on the economic importance of *Syagrus* (Bondar 1939) and *Attalea* (Bondar 1942a), and more detailed studies of *Syagrus coronata* (Bondar 1938) and waxes from palm leaves (Bondar 1942b). Many of these papers are illustrated with wonderful photographs, documenting a way of life that depended on palms in the rural parts of eastern Brazil, a way of life that has all but disappeared.

Bondar's contribution to entomology was much greater. He was one of the first entomologists to document the array of insects that lived on palms. Many of the beetles associated with *Attalea* and *Syagrus* inflorescences were first described by Bondar (e.g., Bondar 1940a, 1940b, 1941a, 1941b). In total, Bondar described more than 400 new species of insect. He also published extensively on other agricultural subjects, especially the cultivation of cacao. A complete bibliography of this publications is given in Silva Filho and Nomura (1981).



Fig. 17. Raspando com facas as folhas de Licuri, os meninos extraem a Cêra de Licuri, grande artigo do comércio. (Scraping licuri wax from leaves of the licuri palm with knives, children extract this important article of commerce.)

3. Scraping wax from the licuri palm (*Syagrus coronata*), from *Palmeiras do Brasil* (Bondar 1964).

Bondar's return to Russia in 1916 and his subsequent imprisonment were the inspiration for a poem by former US poet laureate William Merwin¹ on Bondar entitled "The Moment of Green" (Merwin 1993). Some of the elements in the poem seem to suggest that Bondar, on his return to Brazil, had travelled up the Amazon in Brazil to Manaus, as his predecessors Bates and Wallace had done. Perhaps he did, or perhaps this is poetic license because Bondar apparently returned to Brazil in 1920 via the port of Santos. Like many poets, Merwin has that special gift of obfuscation. Interested in trying to better understand the poem, I turned to an article by Dong Feng (2016). I read: "Like a neurotic suffering from auditory hallucinations, Merwin's Bondar posits an imaginary and indecipherable gaze from the beloved flora and feels compelled to listen to it repeatedly and desperately. This amorous and heavily cathected "shimmer" clearly transcends mortality and historicity, crossing over the speaker's symbolic world toward the unknown parts of nature, as he so marvels at its uncanny indestructibility....."

I don't think that Merwin's poem or Dong Feng's commentary convey much about Bondar, or his life and work. So I finish this article with a story from Bondar himself. In 1940 he published a dense, 160-page treatise on the insect pests of coconuts (Bondar 1940c). This was a technical account, but, on page 98, Bondar drops the formal style and recounts the story of his attempt to identify a species of beetle: "In 1914, when teacher at the Escola Superior in Piracicaba, São Paulo, attending an auction of objects from a German pharmacist, the author bought a bottle of insects in alcohol. Examining the content, among many entomological banalities [*banalidades entomologicas*] he found an impressive larva, with a hard cover about 30 mm long, 12 mm wide, and less than 1 mm thick. Detailed examination did not allow to which entomological family the insect belonged, and there were even doubts about the order in which it should be included. Having travelled to Russia to fulfill his duty as a soldier in the Great War, the author took the larva with him. He visited museums in London, Stockholm and St. Petersburg and

¹ Merwin is also notable for being the founder of a palm garden in Maui, Hawaii, The Merwin Conservancy.

consulted the entomological collections in order to resolve doubts about the larva that he took in a glass tube. No clarification was achieved.

The Russian Empire collapsed; communism came. As a patriot, the author was detained for several months by the communists in a prison in Irkutsk in Siberia, where they deprived him of all his possessions except the larva, guarded as a precious thing, a reminder of the distant and wonderful Brazil. Developing a certain skill, the author achieved freedom and evasion through the border of Mongolia, with several days of walking on foot among the Whites and Reds in the combats of the civil war, in May 1920, deprived of all luggage, only with a cane in his hand and the larva of the genuine Brazilian insect in his pocket, alone in the middle of the woods of the Maca mountains. Hungry as he was, he thought of the last resort – the larva. But this one promised little, being hard as steel.

The author returned to Brazil and settled in Bahia, with the larva always in sight, to solve the problem, to which group and species of insect it belonged. Since the acquisition of the larva, the author judged that it, due to its strange shape, must live in a tight environ-

ment, subjected to the risks of unexpected compression. This medium should be in the center of a palm tree, between the leaves and the trunk, subject to squeezes by the swing of the winds.

The author travelled through many palm groves, looking for suspicious signs of larvae, always with negative results. In 1924, on a visit to the municipality of Viçosa, in the south of Bahia, he went through a coconut grove, always with the same concern about the secret of the larva.

With great joy he noticed blackened bands on the leaf stems, looking like the passage of a slug, which he soon suspected to be the result of the presence of larvae. He went to the owner of the coconut grove and brought several coconut trees to cut down, and found dozens of larvae, the same as the one he possessed."

With these new collections, Bondar was able to identify his larva. It turned out to be a species of hispine beetle that had been described many years previously by a French entomologist, who called it *Platyauchenia latreillei*. The fate of Bondar's much-travelled larva is unknown; his insect collections were distributed to many different institutions.

4. *Cocos vagans* (now *Syagrus vagans*), from *Palmeiras do Brasil* (Bondar 1964).



Fig. 27. *Cocos vagans*, rastejando nos lajedos graníticos. Santa Terezinha, Bahia. (Creeping over the granitic flatrocks.)



**Fig. 8. *Cocos schizophylla*, nos arredores de Salvador, Bahia.
(On the outskirts of Salvador.)**

5. *Cocos schizophylla* (now *Syagrus schizophylla*), from *Palmeiras do Brasil* (Bondar 1964).

In early 1959 Bondar was returning from a field trip with his friend and colleague Dr. Klare Markley² when he became ill and was taken to a hospital in São Paulo. He died on 20th February 1959. In his obituary, Moore (1960) quoted Markley: "In Dr. Bondar's death, the world, and especially Brazil, has lost an outstanding natural scientist....to whom physical discomfort and even extreme hardship, hazards of health and risks of life, and lack of adequate monetary reward meant little and scientific achievement meant everything."

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LITERATURE CITED

- BONDAR, G. 1938. O licuriseiro *Cocos coronata* Mart., e suas possibilidades na economia brasileira. Boletim do Instituto Central do Fomento Econômico da Bahia 2: 1–18.
- BONDAR, G. 1939. Palmeras na Bahia do genero *Cocos*. Boletim do Instituto Central do Fomento Econômico da Bahia 4: 1–19.
- BONDAR, G. 1940a. Notas entomologicas da Bahia. V. Revista de Entomologia 11: 199–214.
- BONDAR, G. 1940b. Notas entomologicas da Bahia. VI. Revista de Entomologia 11: 842–861.
- BONDAR, G. 1940c. Insetos nocivos e molestias do Coqueiro (*Cocos nucifera*) no Brasil. Boletim do Instituto Central do Fomento Econômico da Bahia 8: 1–160.
- BONDAR, G. 1941a. Notas entomologicas da Bahia. VII. Revista de Entomologia 12: 268–303.
- BONDAR, G. 1941b. Notas entomologicas da Bahia. VII. Revista de Entomologia 12: 268–303.
- BONDAR, G. 1942a. A piassaveira e outras palmeiras Attaleaíneas na Bahia. Boletim do Instituto Central do Fomento Econômico da Bahia 13: 1–73.
- BONDAR, G. 1942b. As cêras no Brasil e o Licuri *Cocos coronata*. Boletim do Instituto Central do Fomento Econômico da Bahia 11: 1–86.
- BONDAR, G. 1943. Gregório Gregorievitch Bondar. Revista de Entomologia 14: 313–319.
- BONDAR, G. 1957. Novo gênero e nova espécie de palmeiras da tribo Attaleini. Arquivos do Jardim Botânico do Rio de Janeiro 15: 49–55.
- BONDAR, G. 1964. Palmeiras do Brasil. Instituto de Botânica, São Paulo.
- DONG FENG. 2016. From Eros to Nature: The Impossible Partner in W. S. Merwin's Love Poetry. NTU Studies in Language and Literature 63(35): 63–95.
- GARCEZ, A. 1981. Centenário de Gregório Bondar. Instituto de Cacau da Bahia Salvador.
- MERWIN, W. 1993. Travels. Alfred A. Knopf, New York.
- MOORE, H.E., JR. 1960. Gregório Gregorievitch Bondar, 1881–1959. Principes 4: 61–63.
- SILVA FILHO, J. AND NOMURA, H. 1981. Gregório Gregorievitch Bondar (1881–1959) Biobibliografia. Instituto de Cacau da Bahia Salvador.

² Bondar (1957) described a new genus of palm, *Markleya*, after Klare Markley. This palm is now considered to be hybrid between *Attalea maripa* and *A. speciosa*.

A Unique Anatomical Character Distinguishes *Phoenix atlantica* from Other *Phoenix* Species

LARRY NOBLICK¹ AND ISILDO GOMES²

In the quest to distinguish *Phoenix atlantica* from *Phoenix dactylifera*, many current researchers have ground up its leaflets to extract and analyze its DNA, demonstrating it to be a feralized *P. dactylifera*. This paper has opted to examine anatomically the leaflets rather than grind them. We discovered a unique anatomical character that not only distinguishes *P. atlantica* from *P. dactylifera* but also distinguishes it from nearly all other *Phoenix* species. *Phoenix atlantica* leaflets contain numerous fibrous strands embedded in its mesophyll, giving the cross-sections a unique polka-dot appearance.

Sitting 500 km off the west coast of the African nation of Senegal are nine inhabited islands, one uninhabited island, and several islets of volcanic origin that make up the nation of Cabo Verde (Cape Verde; Fig. 1). Four of the easternmost islands (Sal, Boa Vista, Maio and Santiago) are the home of the endemic palm, *Phoenix atlantica* A.Chev. (Fig. 2). The French Botanist Auguste Chevalier first described this palm in 1935 (Chevalier 1935a) and wrote of it in several other publications (Chevalier 1934, 1935b, 1952). Ever since, botanists and palm enthusiasts alike have been challenged to find the morphological differences that distinguish it from the more widely distributed date palm, *Phoenix dactylifera* L. Chevalier emphasized *P.*

atlantica's clustering habit (2–6 trunks), dark green rather than bluish or glaucous leaves and the acuminate vs. rounded shape of its male flower petals.

The latest revision of the *Phoenix* genus expressed uncertainty about *P. atlantica*'s taxonomic status (Barrow 1998) treating it as an imperfectly known taxon. She suggested that it appeared to be a close relative of *P. dactylifera* but remained undecided as to whether it was a feral date palm, a product of a hybridization event between *P. dactylifera* and another species in the genus, or a distinct species.

Since this revision, several papers have tried to define *P. atlantica*'s correct taxonomic status and especially its relationship to *P. dactylifera*. Chevalier (1934, 1952) and Henderson et al. (2003, 2006) classified it as a possible wild relative. Gros-Balthazard et al. (2017), Flowers et al. (2019), Sarmiento Cabello et al. (2024) and Cid-Vian et al. (2025) classified it as a feral derivative. Henderson et al. (2003) described

¹Montgomery Botanical Center, Coral Gables, Florida, USA.

²Instituto Nacional de Investigação e Desenvolvimento Agrário, Jorge dos Orgaos, Santiago, Cape Verde.

subtle characters that distinguish *P. atlantica* and *P. dactylifera* and raised suspicions that *P. atlantica* is not a distinct species. They also brought up the limitations of not knowing the full morphological variation found in *P. dactylifera*. Henderson et al. (2006) used molecular microsatellite data to show its close relation to *P. dactylifera*, but yet with some unique microsatellite data. They hypothesized that *P. atlantica* is a wild or feral form of *P. dactylifera*.

Gros-Balthazard et al. (2017), after genotyping 37 samples from different Cape Verde islands for 17 autosomal microsatellites and a chloroplastic marker, very bluntly argued that *P. atlantica* is not a separate species. They further wrote that in all cases, *P. atlantica* samples clustered within *P. dactylifera* samples from Africa. Flowers et al. (2019) obtained samples of 71 varieties of *P. dactylifera* and its five closest wild *Phoenix* relatives (including *P. atlantica*) from various sources and conducted whole-genome sequencing analysis. They found *P. atlantica* to be a member of a well-supported *P. dactylifera* clade, attesting to it being a feral date palm.

Sarmiento Cabello et al. (2024) collected 126, 55 and 47 samples, respectively, from the islands of Boa Vista, Sal and Santiago and analyzed them alongside *P. dactylifera* from Tunisia (412) and Djibouti (126) and *P. canariensis* (426). What distinguishes their study from previous studies is the larger sample size. They found 18 microsatellite markers located in the nuclear genome and a minisatellite in the chloroplast genome. Their analyses identified one allele that was almost exclusively associated with *P. atlantica*, except for a single individual of *P. canariensis*, which appeared in a heterozygous form and was possibly a hybrid with *P. atlantica*. From their data, they were able to infer that *P. atlantica* split from the *P. dactylifera* of Tunisia approximately 840 generations ago or 3360–7560 years before the present and prior to any human presence on the islands; the Portuguese being the first to set foot on the islands in the 15th century (Madeira 2016). Genetic differentiation was still lowest between *P. atlantica* and the North African *P. dactylifera*, which suggests a scenario of recent divergence. The larger sample size allowed these authors to characterize *P. atlantica* more accurately than ever before.

Using the most recent molecular techniques, Cid-Vian et al. (2025) were able to analyze the



1. Map of Cabo Verde (Cape Verde).

DNA from the original type herbarium specimen, which showed *P. atlantica* as a monophyletic group nested within the *P. dactylifera* complex. They also compared its seed morphology with *P. dactylifera* and other feralized forms of the date palm and noted that *P. atlantica* have elongated, not spherical seed, much like the more elongated seeds of its cultivated cousin. They recognized *P. atlantica*'s unique status as a feralized *P. dactylifera*, such that both species overlap yet differ in their genetic composition. Enough genetic differences exist to provide future possibilities of crossbreeding it with *P. dactylifera* to incorporate new and beneficial characters. Cid-Vian et al. (2025) argue that *P. atlantica* can be retained as a separate species according to De Queiroz's (2007) species concept, because it evolved independently from the date palm according to two lines of evidence, monophyly and genetic composition. *Phoenix atlantica* clusters most closely with the African lineage of the date palm, which itself is introduced from the Middle East and so its dispersal is thought not a natural dispersal, but a feralized one. Still all of the above studies encouraged conservation efforts to preserve this important endemic palm from Cabo Verde.

In 2024, Montgomery Botanical Center (MBC) was successful in setting up a collaborative project with the Instituto Nacional de Investigação e Desenvolvimento Agrário (INIDA) in Santiago, Cabo Verde, with the objective of obtaining *Phoenix atlantica* seed for propagation for both the Cape Verde Islands and MBC. In addition, INIDA was



2 (top left). *Phoenix atlantica*, Santiago, Praia de São Francisco. Smaller palms than seen elsewhere. 3 (top right). Dead and dying *Phoenix atlantica* on the island of Sal. *Prosopis juliflora* in the background. 4 (bottom left). Dying *Phoenix atlantica* with Juliana Brito and *Prosopis juliflora* to either side, Boa Vista, Floresta Clotilde. 5 (bottom right). Possible hybrid *Phoenix atlantica*, Boa Vista, Cruz das Almas. Many fruits from this palm were seedless or with inviable seed.

interested in exploring other morphological or anatomical differences that might help distinguish *P. atlantica* from *P. dactylifera*.

We determined the best time to find *Phoenix* with mature fruit was late October and November. So, for about two and a half weeks,



6. An oasis of *Phoenix atlantica* in the distance, Boa Vista, Ervatão. Note the volcanic landscape with the Atlantic Ocean on the horizon, sand dunes to the left and beach sands to the right.

the authors searched the islands of Santiago, Sal, Boa Vista and Maio to collect seeds for propagation and leaflet material for study. Our first collection was at Praia de São Francisco on the island of Santiago. The palms were smaller than would be seen elsewhere during our trip, perhaps because of the nutrient poor sandy beach soils (Fig. 2). The fruits were a bit immature and we collected our first voucher and several leaflets from other palms in that same population. Next, we visited Praia Baixo, but postponed our collection until the end of the trip to give the fruits more time to mature. Santiago is the home of the second author and his familiarity with the island helped us to avoid wasting time searching sites where the palm no longer existed or had probably hybridized with introduced *Phoenix dactylifera*.

On November 4, we flew to the island of Sal, where we found several dead and dying palms (Fig. 3). *Prosopis juliflora*, a type of mesquite native to Mexico, South America and the Caribbean, was introduced to the island's barren landscape about 50 years ago, as part of a national afforestation program. This plant grew so aggressively on the islands that it has become an invasive and outcompetes *P. atlantica* for water. As a result, we found dead

and dying palms everywhere this invasive species overlaps with the palm populations. Fortunately, we were able to collect a few palms with fruits and collect our leaflet samples, but we felt discouraged by what we saw on Santiago and on Sal. With so few pure *P. atlantica* populations left on these first two islands, we realized that there is an urgent need to begin propagating this endemic palm from Cabo Verde.

We left Sal on November 6 and flew to Boa Vista, where we spent the next three days. Boa Vista has by far the largest populations of *P. atlantica*. Just as in Sal, we were shocked to see massive numbers of dying palms due to the invasive spread of *Prosopis juliflora* (Fig. 4). We were encouraged, however, by how many healthy populations we found and the efforts by the locals to remove *Prosopis* in areas it overlapped with the palms. We collected most of our fruit and leaflet samples from Boa Vista, and we confirmed many of our collections to be true *P. atlantica* via their anatomy, although some were later determined to be possible hybrids. When we saw one abundantly fruiting palm in Cruz das Almas (Fig. 5), we were thrilled, but when we brought down an infructescence, it turned out that many of the



7. *Phoenix atlantica*, near Morrinho protected within the Parque Natural do Norte do Maio. These healthy palms never produce fruits, but all or most appeared to be male.

fruits were seedless. Leaflet anatomy later confirmed it to be a hybrid. Our final destination on Boa Vista was a large palm oasis called Ervatão on the East coast (Fig. 6). The specimen we collected had the largest infructescence and fruits we had yet seen. We believed that perhaps it was *P. dactylifera*, but the anatomy confirmed it to be a true *P. atlantica*. The molecular results obtained by Sarmiento Cabello et al. (2024) from Ervatão also confirmed that the palm specimens they collected from Ervatão were certainly *P. atlantica*.

Our last stop, the island of Maio, entailed a midday flight back to Santiago on November 9 and an afternoon flight the next day, on November 10, to Maio. We met up with our contacts on Monday, November 11. We were sad to learn that there were very few *P. atlantica* left on the island of Maio, many bearing seedless fruits or no fruits at all. Although the population near Morrinho looked healthy (Fig. 7), we were told that they never bear fruit. After closer examination, we perceived only male trees, which is a good reason not to bear fruit. On a farm near Praia Gonçalves, we found

a tree with a beautiful infructescence, but it bore only seedless fruits (Figs. 8 & 9), and anatomy confirmed it to be a hybrid. Our final stop in Maio was Lagoa, but the only fruits we encountered were tantalizingly beyond the capacity of our pole saw. We spent a total of one day for our collection on Maio, but we could not leave the island until the next available flight to Santiago, which was on the 13th. On November 14, we made our final collection in Praia Baixo of Santiago. We continued to process our voucher collections using Cabo Verde technology, sun drying them on Isildo's rooftop. We then spent many hours cleaning the seeds for INIDA and shipping MBC's seed to the USDA inspection station in Miami. LN left Cabo Verde on a 1:05 am flight on the 16th to Miami via Lisboa. The seed collection was a smashing success, but having already explored *Phoenix* anatomy, it was hard not to be skeptical about how successful our leaflet anatomy studies would be.

Materials and Methods

Plants examined: The areas where we collected our plant samples in Cabo Verde are indicated



8. Hybrid *Phoenix atlantica*, Maio on a farm near Praia Gonalo. This palm produces only seedless fruits.

on the island maps (Fig. 10). Before going to Cabo Verde, one of us (LN) learned *Phoenix* leaflet anatomy by sectioning both the distal

and proximal margins and midveins of the middle leaflets (Fig. 11) of all the *Phoenix* species growing in the MBC collection (10



9. Seedless fruit from the hybrid *Phoenix atlantica* near Praia Gonçalves.

species, 40 specimens, Table 1; Fig. 12). Surprisingly MBC had only two *P. dactylifera*, one collected from Greece in 2019 and another *P. dactylifera* [*Phoenix iberica* D.Rivera, S.Rios & Obón] that was collected from Spain (Figs. 12 & 13). Fairchild Tropical Botanic Garden (FTBG) had none, having lost their only specimen of *P. dactylifera* a few years ago. Therefore, LN had to collect additional *P. dactylifera* from cultivated palms around Miami to obtain a larger sampling of this palm. We acknowledge that unfortunately this material has no known provenance, has an unknown lineage and may have the possibility of hybridization in cultivation.

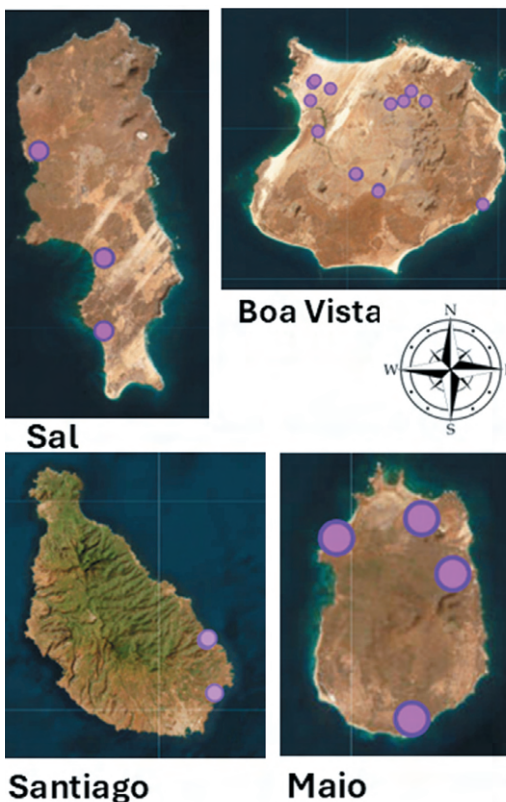
Since MBC and FTBG have very few specimens of *Phoenix dactylifera*, 12 samples of this species were collected throughout Miami-Dade County from streets, freeway offramps, church parking lots, and from the Florida International University (FIU) campus (Fig. 13). Overall, 67 *Phoenix* leaflets were sampled during this study (Table 1), sectioning and imaging both margins and their midribs.

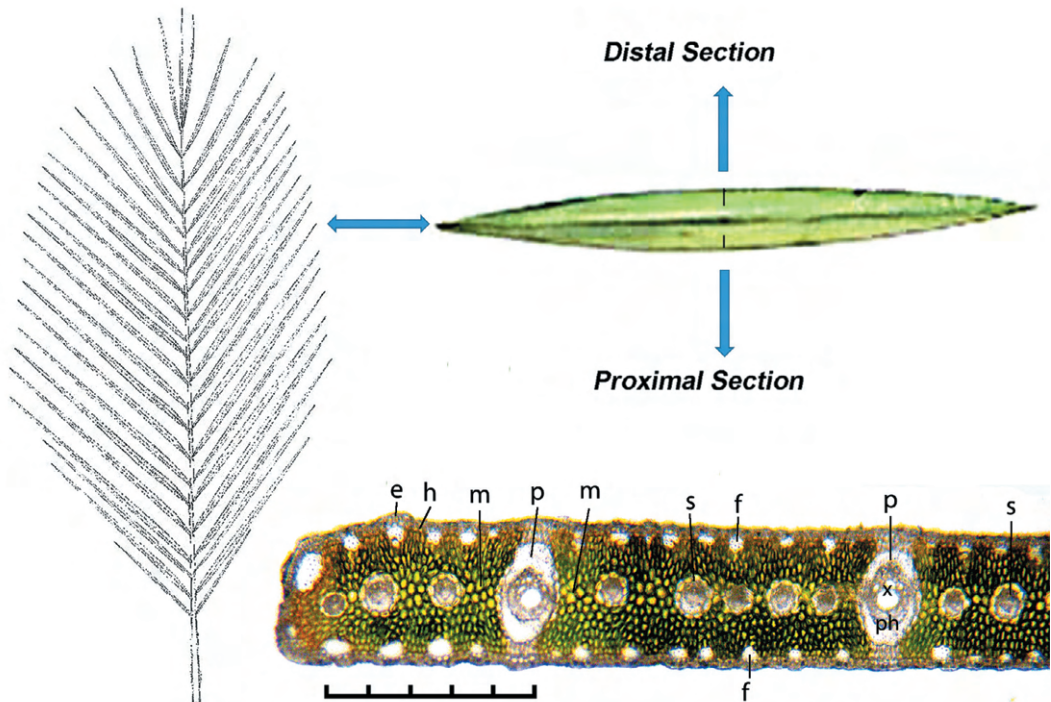
On Cabo Verde, we collected 12 herbarium vouchers to be deposited at INIDA and eventually duplicates for FTG in Miami, 16 fruiting samples, most from Boa Vista and twenty-seven leaflet specimens from Sal (5), Boa Vista (15), Maio (3) and Santiago (4) (Table

2). The locations where we collected are shown on the maps of the individual islands (Fig. 10).

Only fresh leaf material was used to prepare cross-sections of both the proximal and distal leaflet margins for each species (Fig. 11). Midribs were found to contain little information and for this paper we will only focus on the distal leaflet margins illustrated in the figures. Anatomical preparation methods for hand sectioning are covered in detail in Noblick (2013, 2017). To summarize briefly, we used a hand microtome, a straight razor and a carrot cube for hand sectioning. A perpendicular vertical slit was cut in the top of the carrot cube; the leaflet sample was held within the slit and the carrot was then secured in the hand microtome. *Phoenix* leaflets are stiff enough such that they can be mounted with a few millimeters showing above the top of the carrot cube, which allows for thinner sections without having to sort through carrot debris. With the razor and specimen lubricated with water, the straight razor is passed across the microtome plate in a slicing movement while pressing the side of the blade firmly against the plate. The microtome is adjusted

10. Pink dots indicate collection localities in Cabo Verde.





11. Collection sample and cross-section of the distal margin of a *Phoenix dactylifera*. Anatomical labels: e = epidermis, f = fibrous strand, h = hypodermis, m = mesophyll, p = primary vascular bundle, s = secondary vascular bundle, x = xylem, ph = phloem. Scale = 0.5 mm.

upwards about a quarter of a turn after each section, and the sections are then rinsed off into a watch glass of water.

Preparing the slide: A drop of the 1:1 glycerine and water solution was placed onto a clean, labelled slide. While looking through the dissecting microscope, the best sections were transferred from the watch glass to the 1:1 glycerine droplet on the slide using a fine brush. After placing about six to eight sections on the slide, the sections were carefully covered with a glass cover slip, making sure to avoid air bubbles under the slide (Noblick 2013, 2017).

Photography: Prepared slides were placed under a 40–2000× Trinocular Biological Compound Microscope available from Amscope (model T490B) and photographed under the 10× objective (100× magnification). The sections were imaged with a German 5 Mb digital camera from IMAGINGSCOURCE (DFK 33UX264). Three slightly overlapping images of each margin were photomerged, cleaned of background spots, sharpened and adjusted for brightness using Adobe Photoshop. A scale using a stage micrometer was applied to each image.

Results and Discussion

The use of laminar leaflet anatomy to resolve differences between species was successfully employed in the palm genera *Syagrus* (Noblick 2013, 2017) and *Attalea* by the first author (Noblick 2024). Therefore, using leaflet anatomy to resolve differences between *Phoenix atlantica* and *P. dactylifera* seemed worth a try. After earlier attempts at MBC to find differences between *Phoenix* species, this technique seemed hopeless. As all of the *Phoenix* specimens from MBC appeared to have the same basic anatomical pattern with a single row of fiber strands along both the abaxial and adaxial surfaces and a row of primary and secondary vascular bundles arrayed down the center of the mesophyll (Figs. 12 & 13). Some sections were thinner and others thicker and some with thinner fibrous strands and others with thicker fibrous strands. Unsurprisingly the *P. dactylifera* collected from around Miami-Dade, Florida and the single specimen from Greece, displayed the same pattern (Fig. 13) as all of the formerly studied *Phoenix* at MBC. Technically, *P. iberica* of MBC (Fig. 12) is also a *P. dactylifera*, but anatomically it does not match well with the other *P. dactylifera*



12. Anatomical diversity of leaflet cross-sections of *Phoenix* species from the Montgomery Botanical Center. Scale = 0.5 mm.

examined in this study and appears to be the only one with a few fibrous strands in its mesophyll.

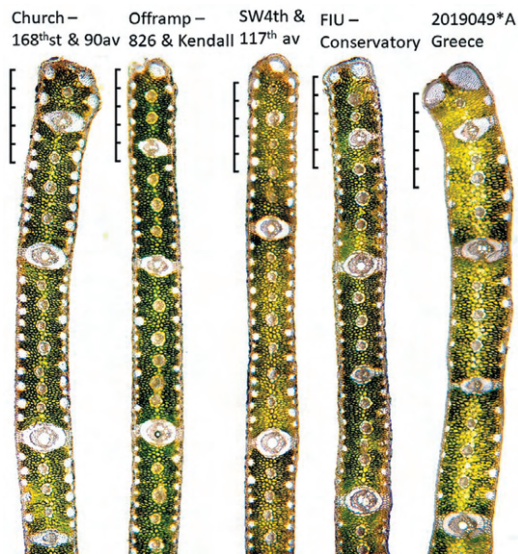
Surprisingly, we discovered the Cabo Verde *P. atlantica* specimens to be quite different. Unlike other *Phoenix*, *P. atlantica* leaflets contain numerous fibrous strands embedded in the mesophyll, giving the cross-section a unique polka-dot appearance (Fig. 14). These fibrous strands are absent or are nearly so in all other species of *Phoenix* studied to date (Figs. 12 & 13). *Phoenix atlantica* that has hybridized with *P. dactylifera* also contain few to no fibrous strands in their mesophyll (Fig. 15) and frequently bear seedless fruits. Besides having the abaxial and adaxial fibrous strands as the other *Phoenix* studied, they were also thicker. Thus, a simple and inexpensive method to determine a genuine *P. atlantica* is to examine its leaflet cross-section.

Again, fibrous strands were found to be absent from the mesophyll in suspected *P. atlantica* hybrids (Fig. 15), although a few strands were always present closer to the midrib. Many of these suspected hybrids bore both seeded and seedless fruits or rather, fruits with inviable seed (Fig. 9) (i.e., Praia Gonçalves in Maio and Cruz das Almas in Boa Vista).

Therefore, using 17th century technology (microscopy), we discovered a definitive way to separate *P. atlantica* from *P. dactylifera*. Important advances to our understanding have

been made using DNA to separate these two species, but microscopy represents an easier and cheaper way to distinguish these two. Although Barrow (1998) explored *Phoenix* laminar anatomy, she must have possessed insufficient leaflet material of *P. atlantica* for her studies, because she makes no mention of it. Nevertheless, molecules do not lie and the many studies done to date conclusively show *P. atlantica* to be a feralized *P. dactylifera*. That being the case, Sarmiento Cabello et al. (2024) suspect that the original *P. dactylifera* arrived on Cape Verde from western African. *Phoenix atlantica* clusters most closely with the African lineage of the date palm, which itself is introduced from the Middle East and so its dispersal is thought not a natural dispersal, but a feralised one. It is unclear how it managed to arrive in the Cape Verde Islands. However, we do suspect that it arrived in the islands long before humans, since it would take more than just a few hundred years for this new anatomical character to appear through a chance mutation on Cabo Verde and to then become well distributed across all of these four islands. According to Sarmiento Cabello et al. (2024), it took millennia.

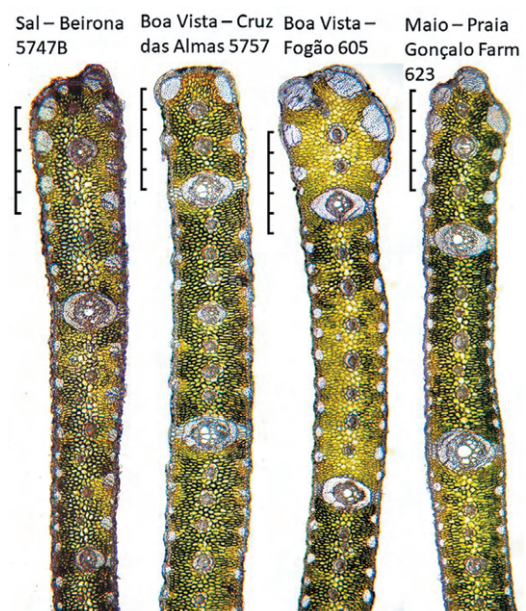
We agree with Cid-Vian et al. (2025) that *P. atlantica* is a new incipient budding species that originated from a feralization event. Had its isolation in Cape Verde continued uninterrupted, it would have continued to distance itself from its cultivated cousin, *P.*



13. *Phoenix dactylifera* leaflet cross-sections collected from various localities around Miami-Dade County, Florida. Scale = 0.5 mm.

dactylifera. Unfortunately, the introduction of other *Phoenix* species to the islands, especially *P. dactylifera*, has genetically adulterated the *P. atlantica* populations, and in some cases lowered its ability to reproduce successfully. Its hybrids are often blessed with seedless fruits, which may in fact represent a positive outcome for some date growers, like seedless grapes and seedless watermelons. Cid-Vian et al. (2025) wrote that a better understanding of the differentiation of *P. atlantica* and *P. dactylifera* is needed to unlock fully the potential of the Cape Verde date palm as a candidate for future date palm improvement.

14. *Phoenix atlantica* leaflet cross-sections from Cabo Verde. Note the fibrous strands in the mesophyll giving the sections a unique polka-dot appearance. Scale = 0.5 mm.



15. Possible *Phoenix atlantica* hybrids. Note the absence or near absence of fibrous strands in the mesophyll of the leaflet cross-sections. Scale = 0.5 mm.

The Cape Verdeans introduced the invasive *Prosopis juliflora* with the best intentions as part of a national afforestation program, but this invasive mesquite species has devastated the native endemic palm populations. As the temperature continues to rise and rain patterns fluctuate due to climate change, *Phoenix atlantica* is among the many endemics that may face extinction (Varela et al. 2022). We witnessed the loss of many endemic palms on the island of Maio due to two back-to-back periods of extended drought. Conservation efforts are necessary to keep the endemic Cape Verde date palm populations healthy. Fortunately, efforts are underway on some of the islands to remove *Prosopis juliflora* where the two species overlap, in order to protect *P. atlantica*, the island nation's only endemic palm.

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Table 1. *Phoenix* samples examined during this study. The accessions with letters are palms from the grounds of Montgomery Botanical Center, Coral Gables, FL and those without letters were from palms that are still in the nursery.

Species	# Samples	Accessions	Country from
<i>Phoenix acaulis</i> Roxb.	2	86524*J, 951193*C	Thailand, India
<i>Phoenix atlantica</i> A.Chev.	27	see Table 2	Cape Verde Islands
<i>Phoenix caespitosa</i> Chiov.	1	2023024I	Oman
<i>Phoenix canariensis</i> Chabaud	5	9716*D, 9718*M, 9719*A, 9767*M, 20010419*C	Canary Islands, Morocco,
<i>Phoenix dactylifera</i> L.	12	see Figure 12	USA
<i>Phoenix iberica</i> D.Rivera, S.Rios & Obón	1	9981*F	Spain
<i>Phoenix loureiroi</i> Kunth	3	76853*F, 95255*D, 951192*B	China, Vietnam, India
<i>Phoenix paludosa</i> Roxb.	1	99875*F	Thailand
<i>Phoenix reclinata</i> Jacq.	8	9712*A, 92165*C, 20110343*B, 20190121*A, 20210116, 20210118, 20210120	Zimbabwe, Kenya, Madagascar, Senegal, Namibia
<i>Phoenix roebelenii</i> O'Brien	2	94331*C, 941563*A	USA
<i>Phoenix theophrasti</i> Greuter	5	20190478*B, 20190485, 20190486*A, 20190495, 20190496	Crete

Varela (Boa Vista), and finally, Ronnie Lima (Delegado substituto do Ministério da Agricultura e Ambiente na ilha do Maio), Ludevina Silva and Paulo Silva Fernandes (Maio). Special thanks to Zuleica Carvalho and Carla Moniz (Santiago) for helping with the final collection on Santiago and help with the seed cleaning. Thanks to César Gomes for minding the sun drying of our voucher specimens. Thanks to Selvyn Valenzuela and Daniel Tucker with helping with the map of Cabo Verde and Joanna Tucker, William Baker and an unknown reviewer for editing suggestions.

LN sincerely thanks his co-author and his wife Dilma Gomes for treating him like family during his two and a half weeks in Cabo Verde and for his brother João Gomes lending him the use of his beautiful apartment.

LITERATURE CITED

- Barrow, S.C. 1998. A monograph of *Phoenix* L. (Palmae: Coryphoideae). Kew Bulletin 53: 513–575.
- Chevalier, A. 1934. Geographie Botanique: Premier aperçu sur la végétation de l'Archipel des Iles du Cap Vert. Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences 199: 1153.
- Chevalier, A. 1935a. Les Iles du Cap Vert. Plantes nouvelles de l'Archipelago des Iles du Cap Vert. Bulletin du Museum National d'Histoire Naturelle 2 ser. t VII: 137–139.
- Chevalier, A. 1935b. Les Iles du Cap Vert. Palmae: *Phoenix* L. Revue de Botanique Appliquée et Agriculture Tropicale 170–171: 1019–1020.
- Chevalier, A. 1952. Recherches sur les *Phoenix* africains. Revue Internationale Botanique Appliquée & d'Agriculture Tropicale 355–356.
- Cid-Vian, J., Et al. In press. Genomics and morphometry of herbarium specimens elucidate the origin of the Cape Verde date palm (*Phoenix atlantica* A. Chev.) and highlight its agronomic potential. Plants, People, Planet. <https://doi.org/10.1002/ppp3.10632>
- De Queiroz, K. 2007. Species concepts and species delimitation. Systematic Biology 56: 879–886.
- Flowers, J.M., et al. 2019. Cross-species hybridization and the origin of North African date palms. Proceedings of the National Academy of Sciences 116: 1651–1658.
- Gros-Balthazard, M., et al. 2017. The discovery of wild date palms in Oman reveals a complex domestication history involving centers in the Middle East and Africa. Current Biology 27: 2211–2218.
- Henderson, S., Gomes, I., Gomes, S., AND Baker, W. 2003. *Phoenix* in the Cape Verde Islands. Palms 47: 5–14.
- Henderson, S.A., Billotte, N., AND Pintaud, J.-C. 2006. Genetic isolation of Cape Verde Island *Phoenix atlantica* (Arecaceae) revealed by microsatellite markers. Conservation Genetics 7: 213–223.
- Madeira, J.P. 2016. Cape Verde: Dimensions in nation building. Humania del Sur 11: 93–105.

Table 2. *Phoenix atlantica* samples. Collection number belongs to Noblick (vouchers of palms with fruit). Other collections are leaflet samples only.

GPS_Num	Coll_Num	Name	Type	Location	Single, suckering or multistemmed
589	5746	<i>P. atlantica</i>	Tree	Santiago - Praia de São Francisco	2 stemmed
589		<i>P. atlantica</i>	2ndary stem	Santiago - Praia de São Francisco	2nd of 5746
589		<i>P. atlantica</i>	sucker near	Santiago - Praia de São Francisco	multistemmed
591		<i>P. atlantica</i> hybrid?	off shoot	Sal - Palmeira	suckering
592		<i>P. atlantica</i>	off Shoot	Sal - Beirona	suckering
593	5747A	<i>P. atlantica</i>	Tree	Sal - Beirona	Many suckers
593	5747B	<i>P. atlantica</i> hybrid?	off shoot	Sal - Beirona	suckering
595		<i>P. atlantica</i>	2ndary stem	Sal - NW of Santa Maria	multistemmed
596	5748	<i>P. atlantica</i>	Tree	Sal-Espargos in town (no leaflets)	single
598	5749	<i>P. atlantica</i>	Tree	Boavista - Floresta Clotilde	single
599		<i>P. atlantica</i>	2ndary stem	Boavista - Floresta Clotilde	multistemmed
600		<i>P. atlantica</i>	2ndary stem	Boavista - Floresta Clotilde	multistemmed
603		<i>P. atlantica</i>	Sucker	Boavista - NW of Rabil airport	suckering
604	5750	<i>P. atlantica</i>	Tree Short	Boavista - Caminho de Bofarreira	single
605		<i>P. atlantica</i> hybrid?	2ndary stem	Boavista - Fogão	multistemmed
606		<i>P. atlantica</i>	2ndary stem	Boavista - Fogão	multistemmed
609	5751	<i>P. atlantica</i>	Tree	Boavista - Fogão	multistemmed
610	5752	<i>P. atlantica</i> hybrid?	Tree	Boavista - Fonte Vicente	multistemmed
611	5753	<i>P. atlantica</i>	Tree	Boavista - Rabil	2 stemmed
612	5754	<i>P. atlantica</i>	Tree	Boavista - Pas Cone (no leaflets)	single
613	5755	<i>P. atlantica</i>	Tree	Boavista - Campo de Serra	multistemmed
614	5756	<i>P. atlantica</i>	Tree short	Boavista - Ribeira de Scriber	single
617	5757A	<i>P. atlantica</i> hybrid?	Tree	Boavista - Cruz das Almas	single
618	5757B	<i>P. atlantica</i> hybrid?	Tree	Boavista - Cruz das Almas	single
620	5758	<i>P. atlantica</i>	Tree	Boavista - Ervatão	multistemmed
622		<i>P. atlantica</i>	Off shoot	Maio - near Morrinho	suckering
623		<i>P. atlantica</i> hybrid?	Young tree	Maio - Praia Gonçalo Farm	single w sucker
623.5	5759	<i>P. atlantica</i> hybrid?	Tree	Maio - Lagoa (single fruit)	multistemmed
624	5760	<i>P. atlantica</i>	Tree	Santiago - Praia Baixo	single

Noblick, L. 2013. Leaflet anatomy verifies relationships within *Syagrus* (Arecaceae) and aids in identification. *PhytoKeys* 26: 75–99.

Noblick, L. 2017. Key to *Syagrus* identification using leaflet margin anatomy: supplement to “a revision of *Syagrus* (Arecaceae)”. *PhytoKeys* 81: 19–43.

Noblick, L. 2024. An anatomical survey of the leaflet margins of the genus *Attalea* (Arecaceae: Arecoideae: Cocoseae: Attaleinae). *Rodriguésia* 75: e01212023.

Sarmiento Cabello, S., t al. 2024. A comparative genetic analysis of *Phoenix atlantica* in Cape Verde. *Plants* 13: 2209.

Varela, D., Romeiras, M.M., AND Silva, L. 2022. Implications of climate change on the distribution and conservation of Cabo Verde endemic trees. *Global Ecology and Conservation* 34: e02025.

Palm Profile

Iriartella stenocarpa



Iriartella stenocarpa thrives in the forest understory of slopes and hilltops of central Acre, Brazil (município of Tarauacá). This delicate, loosely clustering palm stands 5 meters atop short, spikey stilt roots that creep among the leaf litter on the forest floor, and its bright orange fruits split open at maturity to reveal a cottony white mesocarp. Seeds from this palm were collected on an expedition funded by the International Palm Society and Montgomery Botanical Center's Plant Exploration Fund. The red newleaf in the background is an unidentified species of *Geonoma*.

Joanna M. Tucker Lima
Montgomery Botanical Center
Coral Gables, Miami, Florida, USA

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