



Phoenix × arehuquensis nov. hybr. (Arecaceae): The hybrid of *P. canariensis* × *P. reclinata* in garden and forest

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ABSTRACT

Phoenix reclinata Jacq. is a palm species native to tropical and southern Africa, extending to Madagascar, where its natural populations are exploited for sap and fibre. Widely embraced as an ornamental palm in gardens within warm zones abroad, it has established itself as an integral part of horticultural landscapes.

On the other hand, *Phoenix canariensis* H. Wildpret is an endemic species found in the Canary Islands (Spain), forming extensive palm forests. Since the 1850s, it has emerged as the predominant ornamental *Phoenix* palm tree. Interestingly, in various regions, the natural habitat of one species intersects with cultivated individuals of the other. For instance, in southern Africa, where *P. reclinata* is indigenous and *P. canariensis* is exotic, occasional spontaneous hybrids have been reported. These hybrids have also been observed in Florida and California (USA), where both species are cultivated.

In this publication, we formally introduce a new hybrid: *Phoenix × arehuquensis* nov. hybr., originating from the Canary Islands. Additionally, we explore its potential impact on natural palm forests.

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The *Phoenix* genus within the Arecaceae family holds substantial economic and cultural significance, with well-documented morphological and molecular diversity (Barrow, 1998; Pintaud et al., 2010; Rivera et al., 2014). Comprising 13 (Barrow, 1998) to 20 (Beccari, 1890) species of mostly tropical dioecious palms, *Phoenix* palms are pinnate-leafed and include both usually solitary single-stemmed palms like *P. canariensis*, *P. roebelenii*, *P. rupicola*, *P. sylvestris*, as well as multi-stemmed (clustering) species like *P. dactylifera*, *P. caespitosa*, *P. reclinata*. Occasionally, above-ground branched individuals are reported, especially in *P. dactylifera*, or short-stemmed types like *P. acaulis* (Rivera et al., 2022; Obón et al., 2023). These species range from the Cape Verde Islands in the Atlantic Ocean to Hong Kong in the South China Sea.

Phoenix canariensis H. Wildpret, commonly known as the Canarian palm or Canary Island date palm, stands out as a distinctive endemic species of the Canary Islands. While renowned for its horticultural

significance, it has become a popular ornamental palm in subtropical and tropical regions due to its adaptability to various habitats (Spennemann, 2019; Sosa et al., 2021). Recognizable features include tall and thick solitary trunks, densely packed thick acanthophylls in short pseudopetioles, deep green leaflets arranged closely and regularly in a single plane, and relatively small fruits compared to other *Phoenix* genus members (Obón et al., 2018b).

Phoenix reclinata Jacq., native to tropical and southern Africa, Madagascar, and the Comoros Islands, thrives in diverse environments, from rainforest clearings and monsoonal forests to rocky mountainsides up to 3000 m (Barrow, 1998; Palmweb, 2023). Found in both inland and coastal savannas in tropical and southern Africa, this palm species exhibits polymorphic vegetative characters, with variability potentially linked to ecological gradients. Typically forming dense clumps rather than isolated specimens, it is a mid-sized to acaulescent palm with leaves sporting 30–50 (130) leaflets on each side of the rachis and acanthophylls reduced to thin spines with blackish apices (Gyan and Shackleton, 2005). Cultivated in various frost-free or lightly frosty climates, it readily engages in hybridization

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with other cultivated *Phoenix* species (Aubrey, 2004; Palmpedia, 2023).

All parts of *P. reclinata* and *P. canariensis* palms serve a variety of purposes (Kinnaid, 1992; Obón et al., 2018a; Palmweb, 2023). For example, *Phoenix reclinata* (African wild date palm) is esteemed for producing the best fibre for short brushes in the King Williamstown Area, South Africa (Gyan and Shackleton, 2005; Mjoli and Shackleton, 2015). Traditional wine is crafted using sap tapped from the inflorescence (Martins and Shackleton, 2018, 2021). In the case of *P. canariensis*, sap is extracted directly from the palm tree trunk, known as 'guarapo' in the Canary Islands, and consumed fresh or processed (Guarapo, 2024). Fruits are consumed by humans and livestock (Obón et al., 2018a). Cámara-Leret et al. (2014) proposed that in various cultures globally, many palms serve as cultural keystone species; this applies to *P. canariensis* and *P. reclinata*, given their diverse uses in their native regions and widespread cultivation as ornamentals worldwide.

Crossbreeding two different *Phoenix* species yields fertile offspring as they are typically interfertile (Gros-Balthazard, 2013). Since the natural ranges of *P. canariensis* and *P. reclinata* do not overlap, the two species do not coexist naturally, and hybrids are not found in their native habitats. Nevertheless, these two *Phoenix* species are commonly cultivated as ornamentals, with hybridization occurring where they coexist, particularly in nurseries and gardens (Hernández, 2020). Hybrids between numerous *Phoenix* species are observed in locations such as the Universal City Walk in Orlando, Florida (USA) (Hernández, 2020).

At the end of the 19th century, Paul Nabonnand (1860–1937), a French plant breeder, embarked on hybridization experiments with *Phoenix* species. Through a cross between *P. canariensis* and *P. reclinata*, Nabonnand created an formally unnamed hybrid (Nabonnand, 1933), which he mistakenly labeled as "*Phoenix canariensis* species" (sic!). He cultivated 40 specimens of this hybrid, some of which were planted in various gardens along the French Riviera as ornamental palms. Among them, ten specimens of this hybrid were interspersed with *P. canariensis* specimens; by 1933, the *P. canariensis* trees were approximately 35 years old, with trunks reaching 3–4 m in height, while the hybrids reached 5.6 m and displayed a more graceful growth habit.

However, this new hybrid was never formally named and described. Instead, a female individual from this hybrid was used to artificially cross with a male *P. roebelenii* (Nabonnand, 1933; Tournay, 2009). The resulting hybrid, *Phoenix* × *nabonnandii* Nabonnand, was first documented in Rev. Hort. (Paris) 105: 454 (1933); thus, it is an artificial hybrid. The hybrid formula resulting from this artificial cross is *P. canariensis* × *P. reclinata* × *P. roebelenii* (POWO, 2023).

Upon discovering a female specimen in a garden in Arucas (Gran Canaria, Spain), initial observations suggested its affiliation with *P. reclinata*. The chloroplastic marker analysis supported this, revealing an allele characteristic of *P. reclinata*. Subsequent examination of nuclear markers, however, uncovered a mix of alleles from both *P. canariensis* and *P. reclinata*. The chloroplast DNA marker Cpf12 (Pintaud et al., 2010) showed a value of 236 in specimen CAR1645 (HIBAR06) from Arucas, which served as the holotype for the new nothospecies. This value was identical to that of specimen TTT1741 (HIBTT02) from Tierras Trigo (Tenerife). These individuals, cultivated in gardens, exhibited morphological traits resembling a robust *P. reclinata*, with some intermediary characteristics hinting at hybridization with *P. canariensis*. The presence of Cpf12 = 236, typical of *P. reclinata*, rather than the typical 266 for *P. canariensis*, suggests they are likely hybrids resulting from the pollination of female *P. reclinata* by *P. canariensis*. Consequently, our study aims to analyze the morphology of the hybrid specimen, make comparisons with the parent species, and formally describe the new nothospecies. Herein, we introduce the new hybrid *Phoenix* × *arehuquensis* nov. hybr.: a hybrid of *P. canariensis* × *P. reclinata*.



Fig. 1. *Phoenix* × *arehuquensis* nov. hybr. Collecting the type specimen at Arucas (Gran Canaria).

Samples of *Phoenix* × *arehuquensis* were collected in June 2022 from the garden in Arucas (Gran Canaria, Spain), where it naturally occurs (Fig. 1). The name "*arehuquensis*" is derived from the aboriginal name "*Arehuc*" or "*Arehucas*," signifying "land of blessing" where the city of Arucas was founded. This nomenclature pays homage to the city of origin.

Phoenix × *arehuquensis* P.A. Sosa, D. Rivera, Obón, Saro, & P. Pérez nov. hybr.

Type: Spain. Gran Canaria (Islas Canarias), Arucas, private garden in the urban nucleus, 15° 31' 24" W and 28° 7' 13.9" N. UTM 28S, x: 448,601 m, y: 3110667 m. Elevation 278 m a s l. Date: 9 Jun 2022. Collected by P. A. Sosa, D. Rivera, P. L. Pérez de Paz, C. Obón, G. Arbelo, L. Curbelo & P. Rodríguez (TFC 54,276, holo.!, Fig. 2, MA!, K!, ORT!, LPA! iso.), (herbaria acronyms according to Thiers, 2024).

Diagnosis: The hybrid differs from *P. reclinata* by its narrower stipe, 60–90 cm in diameter with leaf bases, and 25–40 (45) cm without leaf base remains, compared with the broader stipe of *P. canariensis*, 90–150 cm and 60–120 cm, with and without leaf bases respectively (Fig. 1). The number of leaves in the crown is intermediate (35–75), between *P. reclinata* (20–35) and *P. canariensis* (75–200). Similarly, the leaf base width is 15–25 cm, compared with 3–15 cm in *P. reclinata* and 25–35 cm in *P. canariensis*. *P. arehuquensis* shares with *P. reclinata*, differing from *P. canariensis*, the following: Spine width 0.5–1 cm, spines with the distal part black, leaflets 50–100 (150), and male flowers petals acute to acuminate. It shares with *P. canariensis* the following characters, in which it differs from *P. reclinata*: external cellulose fibres between young leaves brown, basal pulvinula of spines prominently swollen, female inflorescences 10–15, and female flower petals to 3 mm long, epicarp not adherent.

The description is based on the type material and different parts of the accessions cited in additional specimens examined. The stem



Fig. 2. *Phoenix* × *arehuquensis* nov. hybr. HOLOTYPE. (TFC no. 54,276). Image courtesy of the herbarium TFC, reproduced with permission.

typically ranges from 3 to 15 m in height, with a stipe diameter of 60–90 cm when including leaf base remains and 25–40 (45) cm without leaf-base remains. Underground stems are not known, and above-ground roots are rarely present. Offshoots on the trunk above ground level are absent, and branched specimens have not been observed. The leaf-base remains and scars are diamond-shaped.

The crown usually consists of 35–75 leaves in adult specimens, with each leaf measuring 200–300 cm long and the leaf-rachis 15–25 cm wide at the base. Leaf color varies from deep green to light

green or partially glaucous, with orange-brown cellulose fibres between young leaves. The pseudopetiole (petiole) is typically 70–125 cm long, with a P/L (pseudopetiole vs. leaf length ratio) ranging from 0.35 to 0.41. The basal pulvinula of spines is markedly swollen, with a divergence between basal pulvinula of spines ranging from 60 to 90°. The basal neck in the upper spines of adult leaves measures 0.5–10 mm long, and the 15–25 spines (acanthophylls) on each side of the rachis are usually solitary, occasionally paired, or rarely in groups of three. Spines typically measure 6–20 × 0.4–1 cm,

with a yellow coloration and a black discoloration in the distal part. The basal pulvinula of leaflets are also markedly swollen, with a divergence between basal pulvinula of leaflets ranging from 10 to 30°. Leaflets are 50–100 (150) on each side of the rachis, usually solitary or in pairs. Leaflets at the mid of fully developed leaves measure 25–40 × 2–3 cm and are arranged irregularly in clusters along the rachis, spreading in different planes (quadrifarious) with a feathery consistency. The leaflet apex is very sharp and needle-like, similar in shape and dimensions to the subapical leaflets.

Prominent marginal veins are lacking in the leaflets, and tannin-filled sclerotic cells in the margin of leaflets are also absent. Abaxial ramenta are only present on very young leaves, and they take the form of very thin white scales.

Female inflorescences typically range from 10 to 15. The female prophyll measures 40–50 × 6–12 cm, and the spadix peduncle (inflorescence rachis) is 50–90 × 3.5–6 cm. The color of the female inflorescences can be greenish orange or reddish orange. The peduncle becomes oblique after fertilization and fruit ripening. Female inflorescence rachillae are 30–40 cm long, with bracts subtending female flowers lacking. Female sepals measure 2–3 × 2–4 mm, and petals measure 2–3 × 3–4 mm.

In ripe fruits, the perianth measures 1–2 × 6–7 mm and is orange-tinged. At the Khalal stage, which denotes the fruit reaching maximum size and characteristic identifying color, the fruit has an ovate shape in side view and a circular section. The fruit apex is obtuse, and the apical stigmatic remains inconspicuous or very short. The fruit base is rounded, and the fruit measures 15–18 × 6–9 mm. The breadth/length ratio in fruits is 0.4–0.5.

In its fresh crunchy state, the fruit appears yellow or orange, transforming into amber brown in the soft ripe fruit (Rutab stage). The fruit flesh is 0.7–1.2 mm thick. The fruit consistency is dry, with a moisture content of 15–20 %. The epicarp (peel) is not adherent to the flesh. Regarding fruit quality as food, it is categorized as low to medium, utilizing fruit morphology and organoleptic attributes as criteria (Alam et al., 2023).

The seed dimensions are 8.9–11 (15) × 4–5.5 (9) × 3.7–4.8 (6) mm, with a seed breadth/length ratio of 0.49–0.51 (0.6) (Fig. 3). The seed weight falls within the range of 0.07–0.18 g. The seed shape is elliptical or elliptical-oblong, and the seed apex is obtuse. The seed base is truncate, and the seed surface is smooth. The ventral-furrow of the seed is deep, forming a V- or U-shape, while the dorsal furrow is lacking. Wings or teeth are absent. The seed-testa color is grayish-cream, with the embryo-micropyle situated equatorially. The endosperm color is grayish, and the endosperm is non-ruminate.

In terms of phenology, the species flowers from March to April, with ripening occurring in either June to August or September to October.

Additional specimens examined include accessions identified by their collection code number (Table 1) from the National Phoenix Collection of Spain at the Escuela Politécnica Superior de Orihuela (EPSO) of Miguel Hernández University, Orihuela (Alicante). For specific details, refer to Phoenix Spain (2024). Herbarium sheets were prepared for two of these accessions. Seeds from these specimens were comprehensively studied, and in some cases, as indicated, it was possible to analyze vegetative or floral characteristics (Table 1).

We should note that the *Phoenix × arehuquensis* hybrids used in this study were female specimens from which seeds listed in Table 1 were obtained and photographed. However, the material in the collection (Table 1) likely represents backcrosses with *P. canariensis*, as no male specimens of this hybrid have been identified, therefore vegetative and floral characteristics of the accessions were noted exclusively for the purpose of comparison.

The new hybrid is characterized and distinguished from *P. canariensis* by its small, somewhat glaucous leaves, and from *P. reclinata* by wider leaflets (Table 2) and a single-stemmed stipe. Other morphological characteristics exhibit intermediate values (Table 2).

The morphological evidence presented above is substantiated by molecular data obtained during the comprehensive study of *Phoenix canariensis* hybrids with other species within the Canary Islands (unpublished results). The analysis of nuclear markers will provide a more precise assessment of the involvement of *P. canariensis* in the hybridization process. Regarding nuclear microsatellite SSR, preliminary data indicate the presence of private alleles of *P. canariensis*, particularly when compared with *P. dactylifera*, supporting the notion of hybridization (unpublished data). This suggests that the individual providing the type specimen could be a typical F1 hybrid. In the case of the Tenerife specimen, it cannot be excluded that a hybridization process with the western date palm (*P. dactylifera* L. Western Group) may have occurred in a previous generation, potentially diluting the contribution of *P. canariensis*.

In Bourguet's (2013) study of five *Phoenix reclinata* × *P. canariensis* hybrids from Sanremo (Italy), all were females and exhibited the chlorotype of *P. reclinata*. Similar to the Arucas specimen, these hybrids originated from *P. reclinata* females pollinated by *P. canariensis* males. Among the nuclear markers, *P. reclinata*'s private alleles predominated over those of *P. canariensis*, although a significant portion of the alleles (65–80 %) were not private. This aligns with the



Fig. 3. Seeds of *Phoenix × arehuquensis*. Graph paper scale in millimeters.

Table 1
Specimens raised from *Phoenix × arehuquensis* seeds.

Collection code	Origin	Collectors	Status	Characters
303	Europalms	J. Verhaegen	LO	S
458 *	Havana (Cuba)	I. M. Perez Ruzafa	EPSO, C08	S, V, F
484	Plantier de Costebelle (Hyères, France)	C. Obón and D. Rivera	LO	S, V
485 and 490	Jardin d'Acclimatation Morillon (Toulon, France)	C. Obón and D. Rivera	LO	S, V
536	Jardines de la Finca L'Albarda, Pedreguer (Alicante, Spain)	E. Laguna, D. Rivera, C. Obón.	LO	S, V
690**	El Cabanyal (Valencia, Spain)	D. Rivera	EPSO, D08	S, V, F
1187	Lagoa de Santo André (Alentejo, Portugal)	J. Sánchez-Balibrea	LO	S
1314	Funchal (Madeira, Portugal)	J. Sánchez-Balibrea	LO	S
1468	La Laguna (Tenerife, Spain)	P. Sosa et al.	LO	S
1525	Jardines del Real (Valencia, Spain)	D. Rivera & C. Obón	LO	S
1565	Aruacas (Gran Canaria, Spain)	P. Sosa	EPSO, K09	S, V

NOTE: The seeds not sown were dried and preserved at 5° C. **Abbreviations:** EPSO: Specimens still thriving as of 2023 and location within collections; LO: Specimens lost in the field collections due to *Rhynchophorus* attacks or failed to germinate; S: seed morphology in seeds from the mother plant; V: vegetative; F: floral.

Herbarium sheets: (*) Escuela Politécnica Superior de Orihuela (Spain) accession 458, EPSO C08, 04 Feb 2024, A. Grau (UMH). (**) Escuela Politécnica Superior de Orihuela (Spain) accession 690, EPSO D08, 04 Feb 2024, A. Grau (UMH).

Table 2
Comparison of the plant characteristics of *Phoenix canariensis*, *Phoenix reclinata* and *Phoenix × arehuquensis*.

Traits	<i>Phoenix canariensis</i>	<i>Phoenix × arehuquensis</i>	<i>Phoenix reclinata</i>
Plant height	4–30 m	3–15 m	2.5–15 m *
Stem	single-stemmed	single-stemmed	multi-stemmed
Leaf length	350–700 cm	200–300 cm	100–250 cm
Leaflet length.	20–40 cm	25–40 cm	25–40 cm
Leaflet width	2–4 cm	2–3 cm	1.6–2.6 cm
Fruit	14–23 (26) × 9–15 mm	15–18 × 6–9 mm	13–20 × 6–12 mm
Seed	11–17(20) × 7–11 × 5–9 mm	8.9–11(15) × 4–5.5(9) × 3.7–4.8(6) mm	9–15.5 × 5.5–9 × 5–9 mm

* Populations in West Africa may be even acaulescent.

observation that *P. canariensis* possesses fewer than 20 private alleles, whereas *P. reclinata* has more than 50 (Bourguet, 2013).

This hybrid, *Phoenix × arehuquensis*, was previously reported as a hybrid between *P. canariensis* H. Wildpret and *P. reclinata* Jacq. in Florida (USA) (Garófalo, 2003), the Huntington Botanical Gardens (San Marino, California, USA) (Riffle, 2005), and the reptile area of the San Diego Zoo (California, USA) (Bergman, 2005). Naturally, the ranges of the parent species do not overlap, so hybrids may most often occur in anthropized spaces such as gardens and parks where both species coexist, even at distances of hundreds of meters. Hybrids can also be found in the natural range of one of the parent species if the other parent is grown in orchards or gardens in the area. In the case of South Africa, where *P. reclinata* is a native species and is also cultivated in parks and gardens where *P. canariensis* coexists, albeit not naturally, it is possible that hybrid specimens are found between them.

The present research contributes to the understanding of diversity within *Phoenix*. Given the ornamental potential of this new hybrid, it is cultivated in some gardens and botanical gardens worldwide. This is justified by the fact that the hybrid elegantly combines the characteristics of both parent species.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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