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The date palm with blue dates *Phoenix senegalensis* André (Arecaceae): A horticultural enigma is solved

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ABSTRACT

This study aimed to determine the status, origins and relationships of the *Phoenix* date palm with bluish dates, which is cultivated in gardens and parks and known as *Phoenix senegalensis* or *P. canariensis* "Porphyrocarpa", with other *Phoenix* species.

On one hand, a total of 98 descriptive characters and 398 states related with ecological preferences, phenology and plant morphology, were used to assess the relationships among 11 samples of *P. senegalensis* from Spain, France, Italy and Portugal with 61 samples that represent ten *Phoenix* species: *P. reclinata*, *P. pusilla*, *P. caespitosa*, *P. sylvestris*, *P. atlantica*, *P. theophrasti*, *P. iberica*, *P. abyssinica*, *P. canariensis* and *P. dactylifera*. Also, some hybrids were included such as *P. sylvestris* × *P. dactylifera*, *P. canariensis* × *P. dactylifera*, *P. reclinata* × *P. dactylifera* and *P. canariensis* × *P. reclinata*.

On the other hand, the genetic relationship was evaluated comparing eight microsatellite loci of 7 samples of *P. senegalensis* from Spain, France, Italy and Portugal with 308 specimens of *P. canariensis*, collected from natural populations of five different islands of the Canarian archipelago, together with 40 individuals of *P. dactylifera* collected from different cultivars of Marrakech (Morocco).

Considering the analyzed evidences, the date palms with bluish red fruits traditionally called as *P. senegalensis*, which is cultivated in gardens of Europe at least from the nineteenth century, is considered part of the variability of *P. canariensis* H. Wildpret which is useful for ornamental horticulture.

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1. Introduction

Phoenix date palms with bluish red fruits have been rarely reported in the literature, however a notable exceptional palm is still found in several historical gardens of the French Côte d'Azur, Spanish Levante, Portuguese Sintra region and the Italian Riviera, and in botanic gardens of Lisbon (Portugal), Nice (France) and Rome (Italy) (Fig. 1). Only female typical individuals were described and propagation was done exclusively by means of seeds. Males of this palm are so far unknown. The identity and provenance of this remarkable palm remains obscure and it is subject to discussion whether it is a true species, belongs to a variety of *Phoenix canariensis* H.Wildpret, a variety of other *Phoenix* species such as *P. sylvestris* (L.) Roxb., *P. reclinata* Jacq., or a interspecific hybrid (Laguna et al., 2012). Concerning its geographical origins, it has been supposed to be an introduction from tropical West Africa (Senegal) or from the Canary Islands, or a cultigen that was obtained in Europe. Likely, it was not part of the *Phoenix* introduced by the Spanish in America (Rivera et al., 2013b).

Desfontaines (1829) mentioned *Fulchironia senegalensis* Leseb., and its synonym *Phoenix leonensis* Lodd. as a "*fruticosa*" palm grown in the heated greenhouse at the Jardin de Plantes in Paris. More than a century and a half later Edouard André (1892) published in *Revue Horticole* 64 the name *P. senegalensis* followed by the attribution to Jean Baptiste Leschenault of the species (referring to *F. senegalensis* Lesch. ex Desf.). Additionally, André (1892) described different specimens (general shape and fruits) from Lisbon (Portugal), Golfe Juan and Antibes (France). André (1892) distinguished the taxon from *P. canariensis* and *P. sylvestris*. He underlined the intermediate position of *P. senegalensis* between *P. dactylifera* L. and

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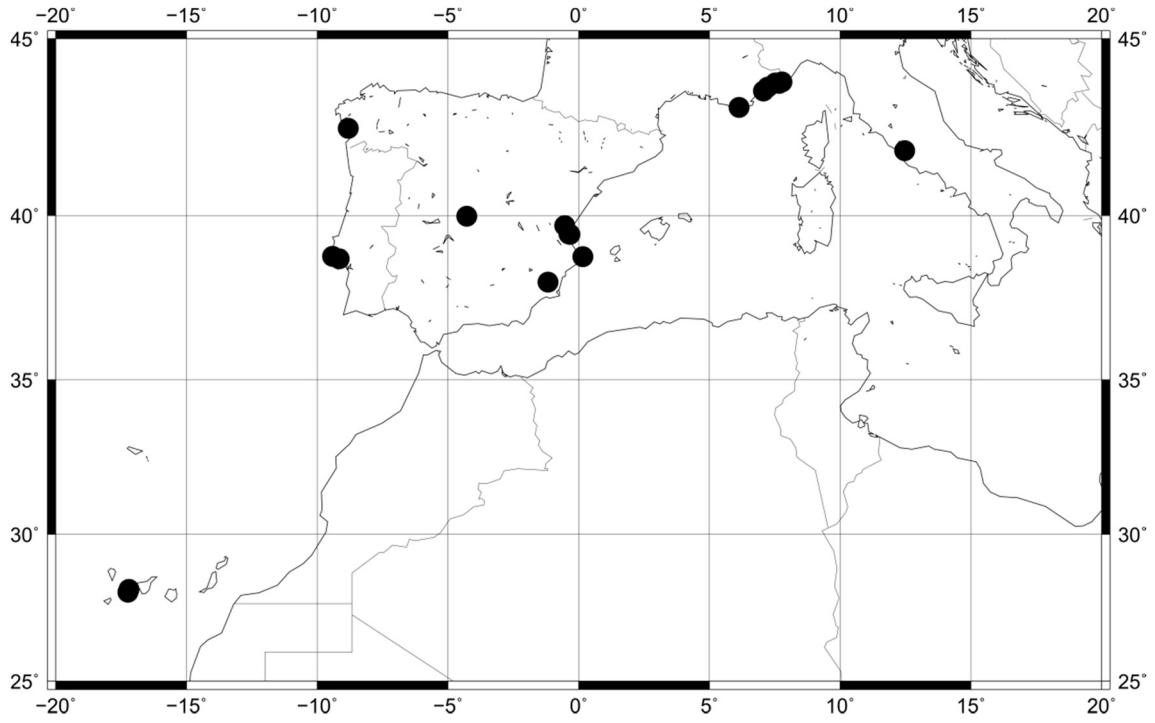

Fig. 1. Localities from where were reported date palms with fruits reddish to bluish under the names of *Phoenix senegalensis* or *P. canariensis* var. *porphyrococca*, or *P. canariensis* "Porphyrocarpa". (Data from Laguna et al., 2012; and original).

P. canariensis, suggesting, thus, a hybrid origin of the taxon. Although André (1892) actually accepted the species he erroneously attributed an African origin to the species and said that it was closely related if not identical to P. spinosa Thonn. Now Phoenix spinosa Thonn. is included in the synonymy of P. reclinata Jacq. (Thyselton-Dyer, 1902; Bailey, 1919; Barrow, 1998), and *P. reclinata* is morphologically unrelated with the *P. canariensis*–*P. senegalensis* complex (Rivera et al., 2008).

André (1893) published the description of *P. senegalensis* fruits. It is compared there with *P. dactylifera* and *P. canariensis*. Sauvaigo (1894) mentions *P. senegalensis* with glaucous leaves grown in the Brunel gardens of Golfe–Juan (France) as a most hardy palm which (fide O. Beccari) would be a hybrid of *P. canariensis* and *P. sylvestris*.

Nardy (1901) mentions *P. senegalensis* with glaucous leaves and bluish fruits grown in the Monserrate park of Sintra (Portugal), however he wonders whether this could be a *P. sylvestris*. Chabaud (1915) described a variety of *P. canariensis* characterized by its glaucous leaves and ripe red to blackish colored fruits and made reference to *P. senegalensis* auct. non Van Houtte and to a living palm being maintained at the Nabonnand rose gardens (Golfe Juan, France). He incidentally mentions that this variety is a hybrid of *P. canariensis*.

Carvalho-e-Vasconcellos and Amaral-Franco (1948) describe another variety of *P. canariensis*, characterized by its ripe deep purple colored fruits (var. *porphyrococca*), from the Lisbon University Botanic Garden. Laguna et al. (2012) reported the individuals grown in different gardens of Eastern Spain.

The field studies (2005–2014) led to determine the presence of isolated specimens of this type in historical and modern gardens of France, Italy, Portugal and Spain and to collect systematically seeds from these.

The aims of the present study is to determine the status, origins and relationships of the *Phoenix* date palm with reddish blue dates which grows in gardens and parks under the name of *P. senegalensis, P. canariensis* var. *porphyrococca* Vasc. & Franco, or *P. canariensis* "Porphyrocarpa". Recovering this information is useful for ornamental horticulture taking into account the interesting fruit color and overall shape of this date palm tree.

Our first challenge is therefore to determine, using morphological characters and molecular markers, if either this is a poorly known species of *Phoenix* (*P. senegalensis* André), a variety of *P. reclinata* or *P. sylvestris*, a hybrid of *P. canariensis* with another species, a cultivar, a botanical variety or a subspecies of *P. canariensis*.

2. Materials and methods

For the present study, the following herbaria have been searched: FI (Odoardo Beccari), FI (Webb), MA, NICE, ORT, P, TLON, UMU. Field studies were developed between 2000 and 2013 in continental Mediterranean Europe and the Canary Islands and in the Phoenix Palm collection of the Spanish Inventory of Plant Genetic Resources at Orihuela (Alicante). Morphological characterization is based for each sample on observations recorded at least under two different environments (years).

2.1. Morphological studies

2.1.1. Plant material

Eleven samples of *P. senegalensis* from Jardim Botanico da Universidade (Lisbon, Portugal) (1) (Fig. 2), Olbius Riquier Park (Hyeres les Palmiers, France) (1) (Fig. 3), Maria Serena Gardens (Menton, France) (1), La Gomera Island (Spain) (1), Hospital of Valencia (Spain) (1), Tomás Font palm collection (Olocau, Spain) (1) (Fig. 4) and Campus de Espinardo (Murcia, Spain) (1), Bordighera (Italy) (1), San Remo (Italy) (1), Hanbury Gardens (Vintimiglia, Italy) (1) and Giardino Botanico (Rome, Italy) (1) were morphologically compared with 61 samples of potentially related species and cultivars. Those cited the literature reviewed as related with *P. senegalensis* were included in the analysis, and species characterized by having bluish or reddish dates were added. These are represented by 4 samples of *P. reclinata* Jacq. from tropical Africa, 4 samples of *P. pusilla* Gaertn. (with bluish dates) from Sri Lanka (2) and S India

Fig. 2. The specimen at the Jardim Botanico de Lisbon cited by André (1892) and Vasconcelos and Franco (1948) (Photo: D. Rivera).

Fig. 3. A centenary pair of *Phoenix senegalensis* specimens in Park Olbius Riquier (Hyeres les Palmiers, France) (Photo: C. Obón). See below, as an insert, an image of the same individuals at the beginning of the 20th century (c. 1911).

(2), 4 samples of *P. caespitosa* Chiov., from Yemen (1), Arabia (1) and E Africa (2), 2 samples of *P. sylvestris* from India, 2 samples of *P. atlantica* A.Chev., from Cabo Verde, 2 samples of *P. theophrasti* Greuter, from Crete and SW Turkey, 2 samples of *P. iberica* D. Rivera et al., from SE Spain, 4 samples of *P. canariensis*, collected from natural populations of Canarian archipelago and 2 from cultivation in France (1) and Italy (1). There were also included, 28 samples of *P. dactylifera* from different cultivars of Spain, North Africa, Ethiopia and West Asia. Finally the following hybrids were also included *P. sylvestris* × *P. dactylifera* (2), *P. canariensis* × *P. dactylifera* (1), *P. reclinata* × *P. dactylifera* (1) and *P. canariensis* × *P. reclinata* (1).

Fig. 4. Detail of *Phoenix senegalensis* fruits at Khalal and Rutab ripening stages (Tomás Font Collection, Olocau, Valencia, Spain). (Photo: D. Rivera).

Descriptions of 61 samples are based fundamentally on field observation of accessions and mother palms, including the whole of *P. canariensis* "Porphyrocarpa" samples. However 11 samples were described exclusively based on bibliographical references: PhabyssiEr (*P. abyssinica*) Drude (1896), Thiselton-Dyer (1902), PharabFY (*P. caespitosa*) Burret (1943), Collenette (1985), PhcaeChi (*P. caespitosa*) Barrow (1998), PhcaeFSo (*P. caespitosa*) Thulin (1995), PhdacLinnR (*P. dactylifera*) Kaempfer (1712), (1P)hdacDhah (*P. dactylifera*) Rhouma and Rami (2005), (1P)hdacAbMea (*P. dactylifera*) Rhouma and Rami (2005), PhibeRiv (*P. iberica*) Rivera et al. (1997), PhzeyZeyl (*P. pusilla*) Bailey (1919), Barrow (1998), Trimen (1885), PhrecCom (*P. reclinata*) Beccari (1906), PhrecJaA (*P. reclinata*) Beccari (1906). Hybrid descriptions were compared with Laguna (2006) and Sauvaigo (1894). (cf. Supplementary Table of Material 1).

The species-level nomenclature follows Barrow (1998) and Govaerts et al. (2011) except for *P. iberica* Rivera et al. and *P. canariensis* H.Wildpret (Rivera et al., 2014). Concerning the authorship of *P. canariensis* is exhaustively discussed in Rivera et al. (2013a).

2.1.2. Descriptive characters and states

We used a total of 98 descriptive characters with 398 states (variables) relating to ecological preferences, phenology and plant morphology that were selected taking into account previous studies (Beccari, 1890; Barrow, 1998; IPGRI, 2005) and observation of the samples analyzed. Of the above, three refer to ecology and phenology, morphological characters comprise 41 which describe vegetative organs of the palm (stem, leaves) (20 quantitative and 21 qualitative) and 54 which describe reproductive organs of the palm (inflorescences, flowers, fruits and seeds) (29 quantitative and 25 qualitative). The terminology used for characters and states correspond to those used by Stearn (1978), Barrow (1998) and IPGRI (2005).

Quantitative characters concerning stems, leaves and inflorescences were measured in the field or using digital images of the specimens at appropriate scales. Quantitative characters of flowers, fruits and seeds were measured using a Mitutoyo Absolute Digimatic 500-202-21 digital caliper with a precision of 0.01 mm. Data were recorded in an Excel database and allometric

relationships (Breadth/Length, Depth/Breadth) and totalized dimensions (Length × Breadth × Depth in mm^3) were automatically calculated using formulas.

Qualitative characters of stems, leaves and inflorescences were analyzed in the field or by digital images of specimens. Qualitative characters of flowers, fruits and seeds were analyzed with a binocular Olympus SZ microscope and with Philips 220CW flat screen.

2.1.3. Morphological data analysis

The information was systematized in a crude matrix with 72 samples (*Phoenix* plant samples) and 398 not mutually exclusive presence-absence descriptors (variables), belonging to the categories described above (2.1.2.). The crude matrix was used to compute a dissimilarity matrix with the Sokal–Sneath index of dissimilarity (un2) ($d_{ij} = 2(b+c)/a+2(b+c)$), where d_{ij} is the dissimilarity between species i and j, a: number of variables where x_i = presence and x_j = presence, b: number of variables where x_i = presence and x_j = absence and c: number of variables where x_i = absence and x_j = absence. These dissimilarities are even and are Euclidean distances. The dissimilarity is = 0 for two species sharing the 398 descriptors and = 1 for two species which present 0 descriptors shared. This analyses and graphics were carried out with DARwin 5.0.158. (Perrier et al., 2003; Perrier and Jacquemoud-Collet, 2006).

Principal coordinates analysis (PCoA), which works on dissimilarity matrices showing the distance between every possible pair of samples, was used to give an overall representation of diversity within *Phoenix* samples with the lowest possible dimensional space. It is just a step in the analysis of the structure of diversity in the *Phoenix* genus.

In order to represent realistically individual relations a hierarchical tree was constructed to describe the relationships between units (samples) based on the common agglomerative heuristic that proceeds by successive ascending agglomerations. For updating dissimilarity during the tree construction the Ward criterion was adopted, which searches at each step for a local optimum to minimize the within-group or equivalently to maximize the between-group inertia. Radial trees were drawn using Dendroscope (Huson and Scornavacca, 2012).

2.2. Molecular studies

2.2.1. Plant material

Seven samples of *P. senegalensis* collected from Valencia Port (Spain) (1), Murcia University Campus (Espinardo, Murcia, Spain) (3), Southern France (1), San Remo (Italy) (1) and Jardim Botanico da Universidade (Lisbon, Portugal) (1) were compared with 308 individuals of *P. canariensis*, collected from natural populations of five different islands of Canarian archipelago: Fuerteventura (44), Gran Canaria (88), Tenerife (44), La Gomera (88) and La Palma (44). It was also included, 40 individuals of *P. dactylifera* collected from different cultivars of Marrakech (Morocco; Dr. M. Baaziz com. pers.).

2.2.2. DNA isolation and microsatellite analysis

Total genomic DNA was extracted from 50 mg dried leaf material using the Plant DNeasy Kit (Qiagen®), following the manufacturer's protocol. Desiccated tissue samples were ground mechanically using a TissueLyser Adapter Set (Qiagen®) to 30 Hertz for two sessions of 30 s duration each prior to DNA isolation. Final DNA concentration was evaluated on a spectrophotometer to verify a successful extraction of at least 20 ng/μL for being used as template in PCR analysis of nDNA. We used eight dinucleotide (GA) microsatellite loci previously developed for *P. dactylifera* by Billotte et al. (2004): mPdCIR010, mPdCIR025, mPdCIR048, mPdCIR050, mPdCIR057, mPdCIR063, mPdCIR070 and mPdCIR085. DNA fragments were amplified in two PCR multiplex reactions with four loci each, using the Multiplex PCR kit (Qiagen®) and following the manufacturer instructions, but accommodating reagents' proportions to a final volume of 15 mL. Amplification products were run on an ABI3730 capillary sequencer using an internal size standard (GS500 (−250) LIZ) and fragment sizes were manually scored using GENEMAPPER v4.0 software (Applied Biosystems, Foster City, CA, USA).

2.2.3. Molecular data analysis

To visualize differences among individuals, a Principal Coordinates Analysis (PCoA) based on pairwise Nei unbiased genetic distances among individuals was performed using the program GENEALEX 6.5 (Peakall and Smouse, 2006). In order to evaluate genetic differentiation among populations, pair-wise divergences among taxa were analyzed using the FST approach implemented also in GENEALEX 6.5.

3. Results

The morphological comparison shows a clear differentiation among individuals of *P. canariensis* and *P. dactylifera*. In the multivariate space defined by PCoA, the two first principal axes accounted for 44.2% and 25.2% of the total variance and separated distinctly *P. canariensis* (Cluster 1, Fig. 5) from *P. dactylifera* (Cluster 3, Fig. 5) individuals, interspecific hybrids (Cluster 2, Fig. 5), *P. theophrasti, P. sylvestris* and other species (Cluster 4, Fig. 5) and, finally, *P. reclinata* and other species (Cluster 5, Fig. 5). In the multivariate space defined by PCoA, *P. senegalensis* samples were mostly ordinated within *P. canariensis* (Cluster 1, Fig. 5).

The hierarchical tree based on the Sokal–Sneath index of dissimilarity (un2) for morphological distance of *Phoenix* individuals constructed using the Ward's minimum variance algorithm corroborates the differentiation of the cluster *P. canariensis–P. senegalensis*. However *P. senegalensis* forms a separate subcluster (Fig. 6).

The microsatellites analyses showed a clear genetic differentiation among individuals of *P. canariensis* and *P. dactylifera*. The two first Principal Components accounted for 60.4% of the total variance (Fig. 7) and separated distinctly *P. canariensis* from the *P. dactylifera* individuals. In the multivariate space defined by PCoA, *P. senegalensis* samples were mostly ordinated within *P. canariensis* cluster individuals, albeit much closer to the occidental Canarian islands individuals (Tenerife, Gomera and La Palma) than the oriental individuals (Fuerteventura and Gran Canaria). There was only one individual from Italy (*P. senegalensis*) clustered close to *P. canariensis* Gran Canaria samples (Fig. 7). Genetic differentiation coefficient among *P. canariensis* and *P. senegalensis* individuals was considerably low (F_{ST} = 0.059; Fig. 8) and no significant ($P > 0.05$). However, the pairwise comparisons of the multi-locus F_{ST} values either between *P. dactylifera* and *P. canariensis* and *P. dactylifera* and *P. senegalensis* were much higher (F_{ST} = 0.289 and 0.231 respectively) and highly significant ($P < 0.001$).

4. Discussion

Morphological differences are a standard basic tool to distinguish species and cultivars in *Phoenix* genus (Barrow, 1998, IPGRI, 2005). However combining morphological and molecular evidence is a more appropriate approach for determining taxonomic and phylogenetic relationships.

The most remarkable character attributed to *P. senegalensis* is the peculiar color of the epicarp. In the initial stage of ripening (corresponding to the Arabic *Kimri* stage for date palm) the fruit color is green and slightly shaded of red,. Then, the fruit takes on

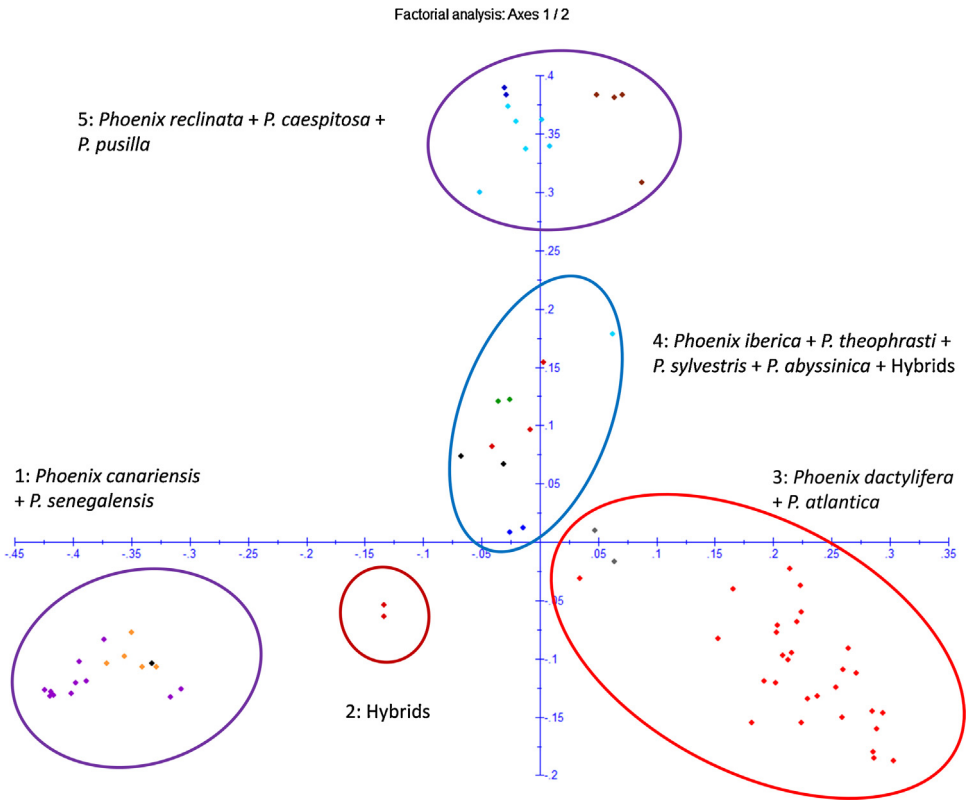

Fig. 5. Principal Coordinate Analysis (PCoA) based on the Sokal–Sneath index of dissimilarity (un2) for morphological distance of *Phoenix* individuals. Axis values are the percentage of total variation explained by the corresponding component.

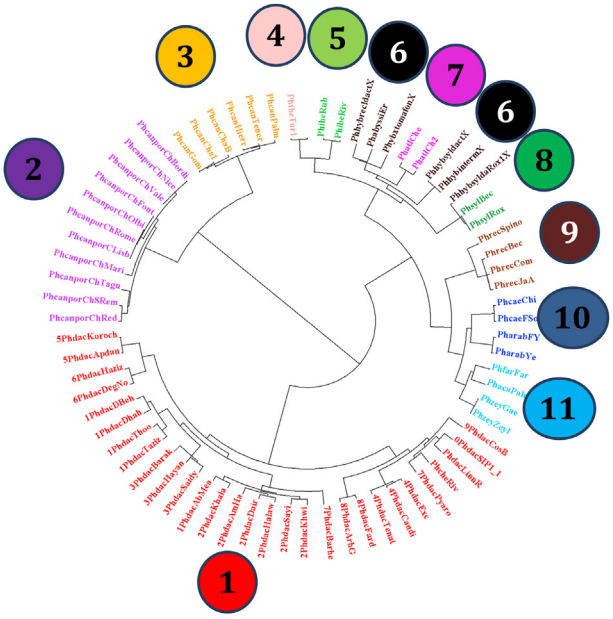

Fig. 6. Hierarchical tree based on the Sokal–Sneath index of dissimilarity (un2) for morphological distance of selected *Phoenix* individuals. For updating dissimilarity during the tree construction the Ward criterion of minimum variance was adopted. Codes: 1 Red, *Phoenix dactylifera* aggr. 2 Purple, *P. canariensis* "Porphyrocarpa" (=*P. senegalensis*), 3 Orange, *P. canariensis* sensu stricto. 4 Pink, *P. theophrasti*. 5 Light Green, *P. iberica*. 6 Black, interspecific hybrids. 7 Magenta, *P. atlantica*. 8 Green, *P. sylvestris*. 9 Brown, *P. reclinata*. 10 Dark Blue, *P. caespitosa* aggr., 11 Light Blue, *P. pusilla* aggr. Radial tree drawn using Dendroscope (Huson and Scornavacca, 2012)(For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

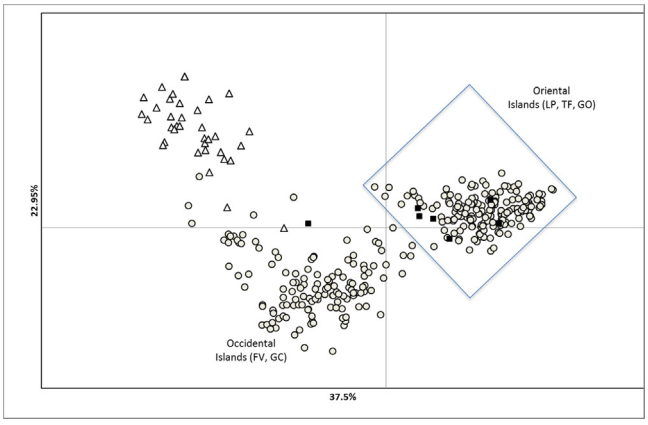

Fig. 7. Principal Coordinate Analysis (PCoA) based on Nei's genetic distance of *Phoenix* individuals. (◯) *P. canariensis*, (■) *P. senegalensis*, (△) *P. dactylifera*. Axis values are the percentage of total variation explained by the corresponding component. LP: La Palma, TF: Tenerife; GO: La Gomera; FV: Fuerteventura; GC: Gran Canaria.

a reddish hue ranging from coral red to purple in the *Khalal* (or *Bser*) stage. This led botanists and gardeners to use such names as *Porphyrocarpa* or *Porphyrococca*, from the Greek *Porphyros* (purple), to distinguish this palm. During normal ripening process, in the next stage fruits develop a bluish color, usually covered with a waxy bloom. This stage is equivalent to what is known as *Rutab* in date palm (*P. dactylifera*). Finally, the fruits have a blackish color, stage that in the date palm is called *Tamr*. At Hyeres (France) and La Mortola (Italy) sometimes ripening process stops at the *Khalal* stage and then fruits acquire a brownish color during degradation of mesocarp.

The clustering of *P. senegalensis* samples based on morphological evidence, links strongly *P. senegalensis* to *P. canariensis*, but it

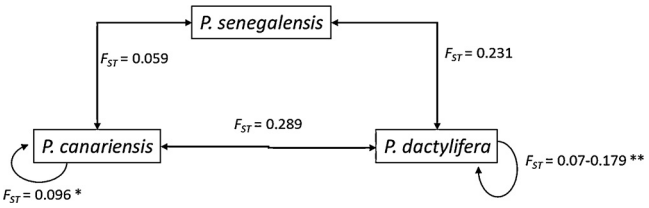

Fig. 8. Genetic differentiation coefficients (F_{ST}) among samples of *P. canariensis*, *P. dactylifera* and *P. senegalensis*. *Data from Saro et al. unpublished. **Data from Arabnezhad et al. (2012).

separates clearly within the variability of this species. *P. senegalensis* and *P. canariensis* share numerous character states which mark them as closely related: large wide trunks up to 100 cm in diameter, suckering offshoots at base lacking, numerous leaves 80–180 and 100–200 respectively, acanthophylls yellow, numerous leaflets (150–200), fruits ovoid to oblong-elliptical 14–25 × 9–16 mm, flesh 1–2 mm thick, seeds oblong-elliptical, 11–20 × 7–13 mm. The separation is not only due to the peculiar colour of fruits, but also to several vegetative characters: shorter leaves (3–4(5) m instead of 4–6 m), usually glaucous, higher number of basal acanthophylls in each leaf side ((4)15–25 instead of 4–15), pseudopetiole relatively longer (40–70 cm instead of 30–50 cm), numerous leaflets grouped in pairs instead of single. The reviewed literature links the bluish fruits to somewhat glaucous leaves (Chabaud, 1915, Nardy, 1901, Sauvaigo, 1894), which contrasts with the deep green leaves of *P. canariensis* or *P. reclinata*. However the presence of glaucous leaves is not an exclusive character, because *P. dactylifera, P. theophrasti, P. sylvestris, P. pusilla* and *P. iberica* often present glaucous leaves.

Morphologically the studied specimens of *P. senegalensis* are unrelated to *P. sylvestris*, *P. reclinata* or the hybrids analyzed. Notably, *P. dactylifera* hybrids with *P. reclinata* or *P. sylvestris* enter into the same cluster as *P. canariensis* hybrids with *P. reclinata* or *P. dactylifera* (Figs. 5 and 6) and are more or less morphologically related with *P. atlantica* and *P. sylvestris*. Therefore morphologically *P. senegalensis* is not an intermediate between *P. canariensis* and other species, but a well-defined group within the variability of *P. canariensis*.

Neutral markers are useful in estimating the relative evolutionary importance of genetic factors such as gene flow and genetic drift, and in clarifying the relationship between closely related taxa (Frankham et al., 2002; González-Pérez et al., 2009). Microsatellites have been especially suited to identify date palm *P. dactylifera* cultivars (Ahmed and Al-Qaradawi, 2009; Elmeer et al., 2011; Zehdi et al., 2012; Arabnezhad et al., 2012) and different *Phoenix* species (Henderson et al., 2006; Arabnezhad et al., 2012; Saro et al. unpublished). The current molecular results, clearly separates *P. canariensis* and *P. dactylifera* species, with F_{ST} values higher than 0.231 (Fig. 8). This value is similar to those described between other *Phoenix* species (Pintaud pers. comm.). However, all *P. senegalensis*, were grouped very close together, at the same PCoA cluster (Fig. 7), with F_{ST} values lower than 0.06. This value is lower than those F_{ST} values obtained among natural pairwise populations of *P. canariensis* in the archipelago (average F_{ST} = 0.096; Saro et al. unpublished) and higher values of F_{ST} has been also described between different cultivars of *P. dactylifera* from Tunisia (Range 0.0027–0.222, Zehdi et al., 2012); Iranian date palms (range 0.07–0.179, Arabnezhad et al., 2012). So, we expected a higher F_{ST} value for pairwise comparison between *P. senegalensis* and *P. canariensis* samples. Values of multi-locus F_{ST} are adequate to test the relationships between two taxa, because this parameter reflects the role of gene flow as a force of genetic cohesion (González-Pérez et al., 2009). Although only seven individuals of *P. senegalensis* were analyzed, the microsatellites were successfully used as powerful neutral markers to show clearly that both taxa *P. canariensis* and *P. senegalensis* share the same genetic pool.

Concerning geographical origin we have found this variety growing in several localities of La Gomera, Fuerteventura and Gran Canaria (Canary Islands, Spain). In La Gomera it could be related with the "Palmas moriscas", with blackish fruits, reported in the eighteenth century (1772–1783) from this island (Viera and Clavijo, 1866). However most *P. canariensis* specimens present typical greenish leaves and yellowish dates, and no pure populations of blue dates palm were found.

5. Conclusions

Overall the date palms with reddish blue fruits, which are cultivated in gardens of Europe at least from the nineteenth century that has received names such as *P. senegalensis* are part of the variability of *P. canariensis* H.Wildpret pool and must, properly, be named *P. canariensis* var. *porphyrococca* Vasc. & Franco if it is accepted as a variety of *P. canariensis*, or *P. canariensis* "Porphyrocarpa" as a cultivar.

This variety of palm was originated in the Canary Islands. These are splendid ornamental palms that merit becoming widely cultivated in Mediterranean style gardens, and nurseries and growers may seriously consider introducing this palm in their catalogues (only a few ones in France actually offer seeds or plants for sale). However, there is still much to be done, since information on reproductive characteristics is mostly lacking. We are currently growing seedlings from the studied individuals (from France, Italy, Portugal and Spain) at the Phoenix Palm collection of the Spanish Inventory of Plant Genetic Resources at Orihuela in order to determine the persistence of the distinctive characters through generations.

The most important references for understanding morphological trait description for *Phoenix* are very old and quite difficult to find, hence the need for a comprehensive study of the diversity of genus *Phoenix* including species, hybrids and cultivars.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.scienta.2014.10.010.

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