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Morphological and genetic variation of *Chamaerops humilis* (Arecaceae) in relation to the altitude

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Abstract. The Mediterranean dwarf palm (*Chamaerops humilis* L.) is native to Western and Central Mediterranean. Since classical times this species has been cultivated and several varieties have been described on material of unknown origins. In this study, plants grown from seeds collected in the wild from seven populations spread along the Mediterranean basin were cultivated under the same environmental conditions, investigated morphologically and genetically by screening the polymorphism of ten SSR loci. Two groups are clearly separated, the populations growing at low altitudes and those living above a thousand meters of altitude. Due to morphological, geographic and environmental isolation, here it is proposed to discriminate the populations growing at high altitude on the Moroccan High Atlas and Anti-Atlas as a distinct subspecies.

Keywords: European fan palm, dwarf fan palm, morphology, diversity, SSR markers, Morocco.

INTRODUCTION

The Mediterranean dwarf palm, *Chamaerops humilis* L. (Arecaceae) is one of the best known and typical species of the Mediterranean basin. This is due to its wide distribution and to its numerous uses since the dawn of civilization. *C. humilis* has been studied in relation to morphological and genetic diversity (Giovino *et al.* 2014, Giovino et al. 2015a, Guzmán *et al.* 2017), seed lipids composition (Giovino *et al.* 2015b), ethnobotany (Okkacha *et al.* 2013).

This species naturally occurs in Western and Central Mediterranean. It is widespread in the Iberian Peninsula, Morocco, Algeria, South France, Sardinia, Tunisia, Sicily and Peninsular Italy (Euro+Med 2006, Castroviejo and Galan 2007, Pignatti 2017). The eastern distribution limit of this species lies in Calabria, Italy. Linnaeus (1753) reported *C. humilis* as common in Spain.

The original material used for lectotypification of this name is presumptively collected in Europe (Moore and Dransfield 1979).

To date, the dwarf palm is considered a species threatened by human activities and environmental and climatic changes and for this reason deserves a special attention in conservation management strategies (Blach-Overgaard *et al.* 2010; Giovino *et al.* 2016).

Chamaerops humilis is extremely variable in height, leaf colour, presence of thorns, size and shape of fruits (Beccari 1921, Zagolin 1921, Maire 1957). This large morphological variation is at the basis of the description of numerous varieties. Despite the Kew Checklist of Palms (Govaerts and Dransfield 2005) reports more than 20 intra-specific epithets among varieties and sub-varieties, Giovino *et al.* (2014) reports that many morphological traits appear to be related to environmental conditions. This scenario is complicated by the fact that a large part of known varieties has been described on cultivated plants of unknown origin. Whilst a great number of names are used in the horticultural field, only two varieties are widely accepted in floras: *C. humilis* L. var. *humilis* and *C. humilis* var. *argentea* André (= *C. humilis* var. *cerifera* Becc.). They are mainly distinguished by leaves color: *C. humilis* L. var. *humilis,* has green leaves and *C. humilis* var. *cerifera* Becc. has grey and waxy leaves (Maire 1957).

The aim of this contribution is to investigate the taxonomic value of *C. humilis* var. *argentea* André and to clarify if the morphological variability observed in high altitude populations studied in High Atlas and Anti Atlas in Morocco is merely due to environmental factors or if it is of genotypic nature and transmitted to progenies.

MATERIALS AND METHODS

A preliminary assessment of the morphological variability of *C. humilis* in all the countries where it naturally occurs was performed. We were not able to find any wild individual in the Maltese archipelago, where this species was recorded by Haslam *et al.* (1977). After this preliminary evaluation, seven representative populations were chosen for this study.

In order to exclude variability due to the environment, plants grown from seeds collected in nature were studied *ex-situ* under the same environmental conditions in a collection field at the CREA-DC Research Center - Bagheria (N Sicily). These seeds were collected from three populations in Morocco (Terketen, BeniMellal, and Touama) (Figure 1), one population in Spain (Valencia), one in Algeria (Sidi Belattar near Mostaganem), one in Tunisia (Cap Serrat), and one in Sardinia, Italy (Porto Tangone) (Table 1). Seed collections were done on at least six individuals occurring in the central part of wild populations. In December 2013, seeds were treated with either sulphuric acid, water or mechanical scarification as described in Giovino *et al.* (2015b). After, seeds were germinated on humid sand for about 100 days (MGT) in a cold greenhouse with temperatures between 12 °C and 16 °C at relative humidity of 90%. After germination plants were transplanted on pots of 1.6 ℓ containing a mixture of sand (70%), red soil (25%) and commercial garden soil (5%). Pots were maintained on open air from April to November and irrigated with 1 dripper 2 ℓ/h providing 2 min irrigation per day for three days a week. After two years plant were transplanted in 7 ℓ pots containing the same substratum.

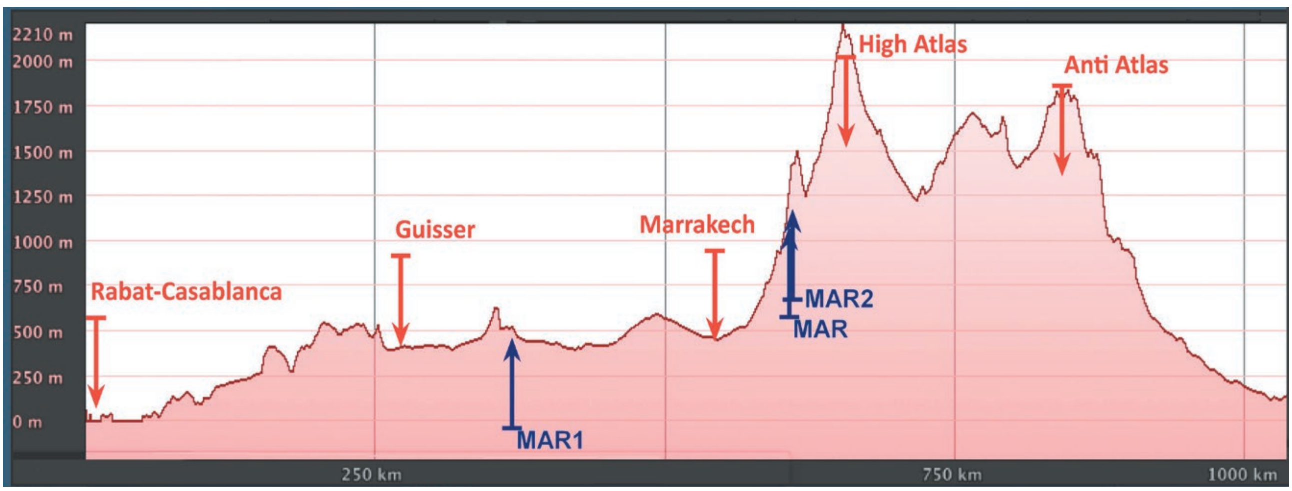

Figure 1. Elevation of the collecting localities in Morocco. MAR: Terketen; MAR1: Beni Mellal; MAR2: Touama.

Table 1. Sampled populations, environmental characteristics and seeds collection data.

Code	Locality	Latitude	Longitude	Altitude m a.s.l.	Habitat	Bioclimate	Date	Collector
MAR	Terketen, Morocco	31°27'44.47"N	7°24'23.39"W	1420	Mediterranean steppe	Humid	21.10.2012	A. Giovino
MAR1	Beni Mellal, Morocco	32°25'54.78"N	6°30'41.76"W	430	Mediterranean maquis	Semiarid	21.10.2012	A. Giovino
MAR2	Touama, Morocco	31°31'46.14"N	7°28'59.82"W	990	Mediterranean steppe	Humid	21.10.2012	A. Giovino
SPA	Valencia, Spain	40°16'15.12"N	0°17'12.04"E	130	Mediterranean maquis	Semiarid	15.10.2012	P. Ferrer Galego
ALG	Sidi Belattar, Algeria	36°01'43.07"N	0°09'03.03"E	200	Mediterranean maquis	Semiarid	5.9.2013	A. Mostari
TUN	Cap Serrat, Tunisia	37°11' 55.8"N	09°15'45.9"E	20	Mediterranean maquis	Humid	5.9.2013	R. El Mokni
SAR	Porto Tangone, Italy	40°28'19.23"N	8°22'52.98"E	50	Mediterranean maquis	Semiarid	25.06.2013	A. Giovino

For morphological analysis, the selection of characters was done on the basis of Rhouma (1994, 2005), Hammadi *et al.* (2009), Rizk and El Sharabasy (2007).

Measures were done in spring 2018 with a digital caliper. For each character three measures were performed and their arithmetic average registered. Per each population 31 individuals were measured. On the whole 12 quantitative characters were measured; nine continuous: Height of the stem (cm), Height of the plant (cm), Crown diameter (cm), Stem diameter (mm), Petiole length (cm), Petiole width (cm), Leaf length (cm), Leaf width (cm), Leaf thickness (mm) and three discrete ones: No. of leaf segments, No. thorns on the petiole, and wax coverage density. This latter was estimated on percentage of coverage on the upper surface of the leaf.

The measures used for statistics are presented in the Supplemental data (File 1). According to the methodology adopted in Giovino *et al.* (2015c), Domina *et al.* (2017a, 2017b), and Domina (2018) these characters were subjected to a Principal Component Analysis, with the individuals a priori assigned to the eight populations (Figure 2). Each character was also subjected to univariate analysis (analysis of variance or Kruskal–Wallis test with corrections for multiple comparisons, Pearson correlation coefficients, Tukey's HSD, honestly significant difference, test and Bonferroni, respectively),

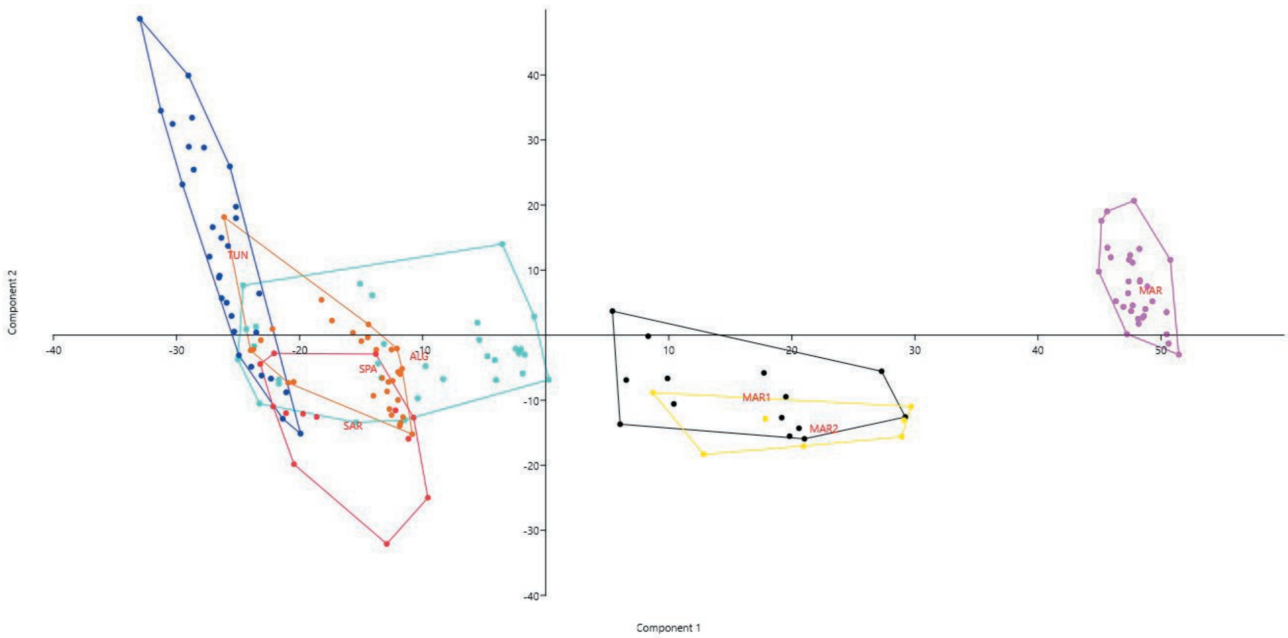

Figure 2. Principal components analysis based on the 12 considered morphological characters, with 7 a priori defined groups based on the geographical distribution of the sampled populations. PC1 Eigenvalue 645.724, % variance 76.48, PC2 Eigenvalue 132.387, % variance 15.68. MAR: Terketen, Morocco; MAR1: Beni Mellal, Morocco; MAR2: Touama, Morocco; SPA: Valencia, Spain; ALG: Sidi Belattar, Algeria; TUN: Cap Serrat, Tunisia; SAR: Porto Tangone, Sardinia, Italy.

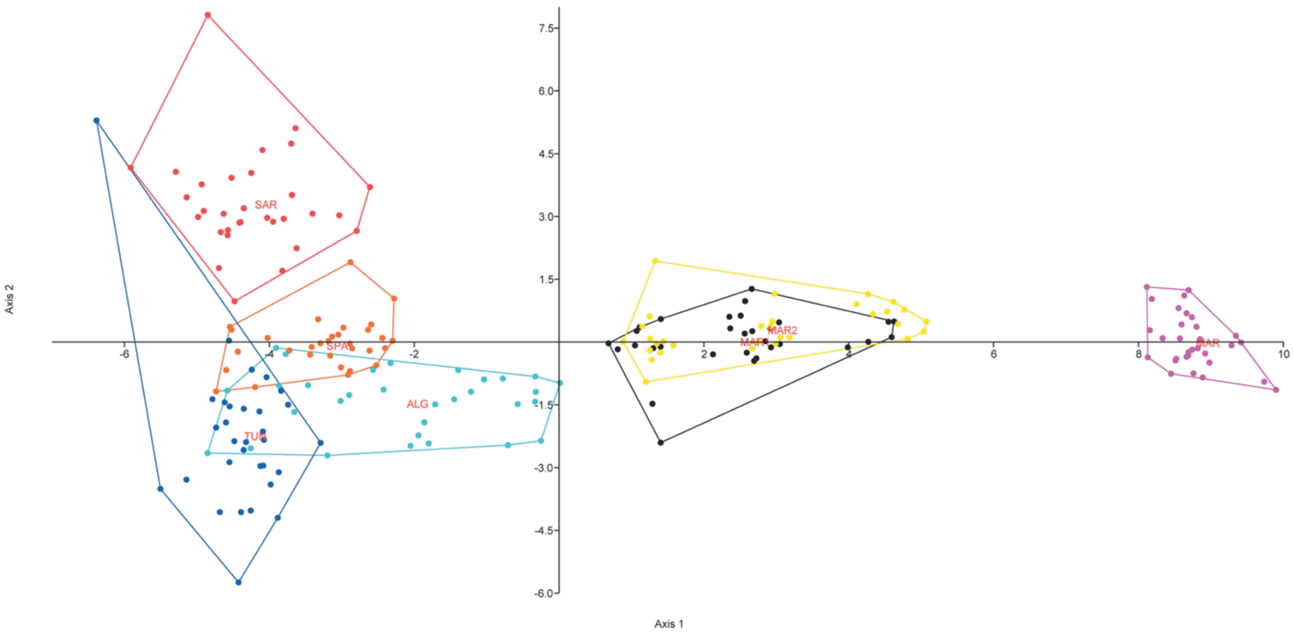

Figure 3. Discriminant analysis based on the 12 considered morphological characters, with 7 a priori defined groups based on the geographical distribution of the sampled populations. Axis 1: Eigenvalue 22.424, % variance 74.11; Axis 2: Eigenvalue 5.635, % variance 18.62. MAR: Terketen, Morocco; MAR1: Beni Mellal, Morocco; MAR2: Touama, Morocco; SPA: Valencia, Spain; ALG: Sidi Belattar, Algeria; TUN: Cap Serrat, Tunisia; SAR: Porto Tangone, Sardinia, Italy.

using PAST version 4.03 (Hammer et al. 2001; Hammer 2020). Pearson correlation coefficients (r) among the 12 characters measured are presented in the Supplemental data (File 2). A discriminant analysis for the seven a priori recognized groups was performed. The scatter plot of specimens along the first two canonical axes is shown (Figure 3). The range of each continuous numerical character is represented using box-and-whisker plots (Figure 4).

For molecular analysis a total of 35 genotypes were used for the characterization: 5 from Terketen (Morocco); 5 from Beni Mellal (Morocco); 4 from Touama (Morocco); 6 from Valencia (Spain); 6 from Mostaganem (Algeria); 3 from Cap Serrat (Tunisia), and 6 from Porto Tangone (Sardinia, Italy).

Genomic DNA was extracted from 40 mg of dried leaf sample using Doyle & Doyle (1987) protocol. A set of 10 microsatellite markers was employed, including 6 microsatellites showing trinucleotide repeats (Arranz *et al.* 2013) and 4 showing dinucleotide repeats recently isolated in fan palm by Giovino *et al.* (submitted 2020) following PCR conditions and thermal cycles reported in Giovino *et al.* (2014) and Giovino *et al.* (submitted 2020) (Table 2). PCR products were analyzed using an ABI 3130 Genetic Analyzer (Applied Biosystems) and allele sizes were established using GENEMAPPER, version 4.0 software (Applied Biosystems).

Basic genetic parameters including the number of alleles per locus (Na), observed (Ho) and expected heterozygosity (He), the total number of null alleles (Fnull), the polymorphic information content (PIC) value and the deviation from the Hardy-Weinberg equilibrium (HWE), inferred by sequential Bonferroni correction, in the 36 selected genotypes, were calculated using CERVUS 3.0 software (Marshall et al. 1998; Kalinowski et al. 2007).

A Neighbor-Net graph was constructed based on calculations of Reynold's genetic distances with SPLITSTREE (Huson and Bryant 2006) in order to study the genetic diversity and relationships between palm genotypes (Figure 5).

RESULTS

Morphological characterisation

Single morphological characters (Figure 4) show continuous variation and do not distinct population groupings. The population from Cap Serrat shows the largest intra-population variation. Only the leaf length distinguishes, in part, some populations from the others. Univariate analysis shows that this character discriminates Moroccan populations from the others.

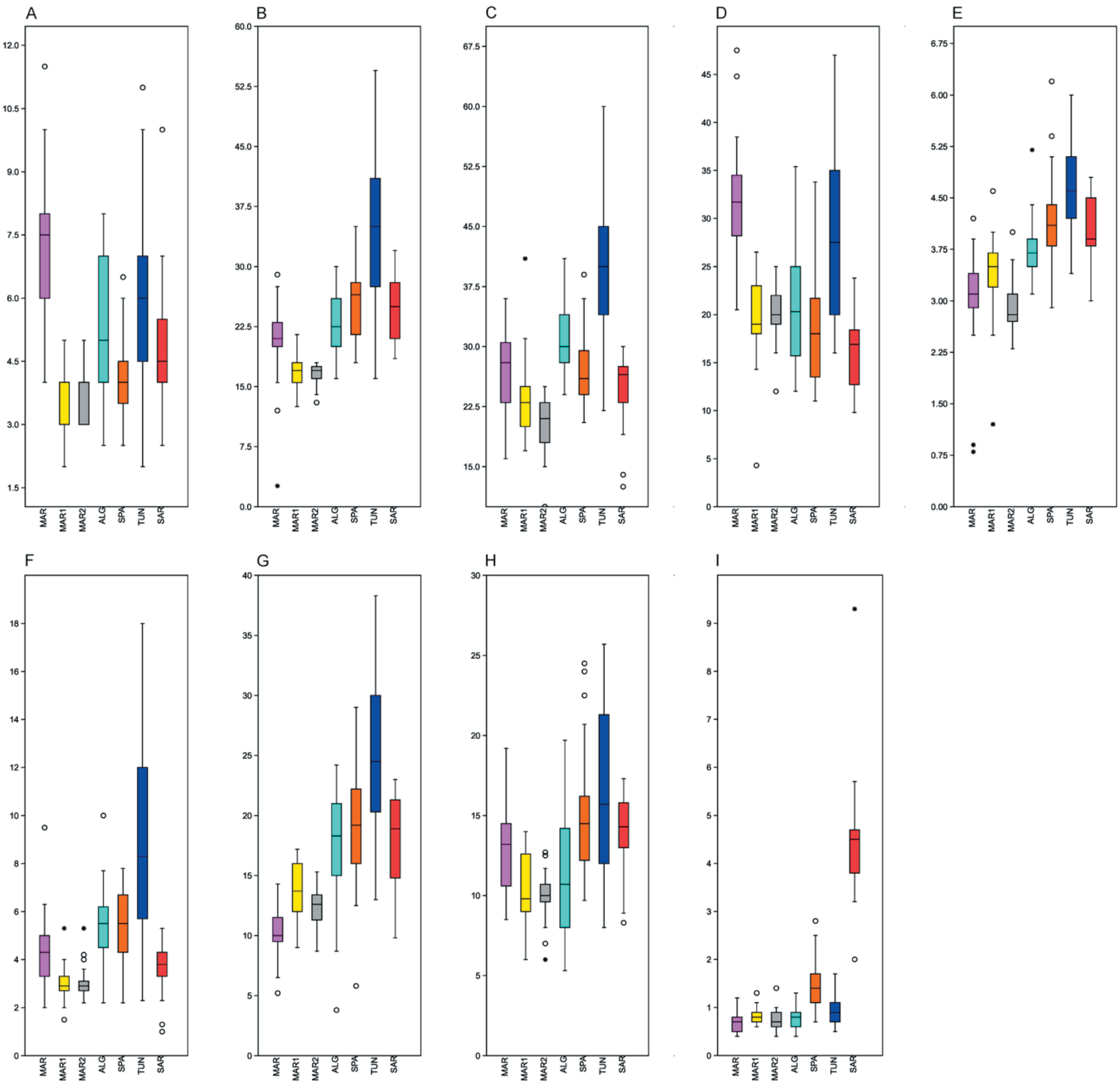

Figure 4. Box-plots of the 9 continuous morphological characters considered (A: height of the Stem (cm); B: Height of the Plant (cm); C: Crown diameter (cm); D: Stem diameter (mm); E: Petiole length (cm); F: Petiole width (cm); G: Leaf length (cm); H: Leaf width (cm); I: Leaf thickness (mm). For each sample, the 25–75% quartiles are drawn using a box. The median is shown with a horizontal line inside the box. The whiskers are drawn from the top of the box up to the largest data point less than 1.5 times the box height from the box, and similarly below the box. Values outside the inner fences are shown as circles, values further than 3 times the box height from the box are shown as stars. MAR (fuchsia): Terketen, Morocco; MAR1 (yellow): Beni Mellal, Morocco; MAR2 (grey): Touama, Morocco; ALG (light blue): Sidi Belattar, Algeria; SPA (orange): Valencia, Spain; TUN (blue): Cap Serrat, Tunisia; SAR (red): Porto Tangone, Sardinia, Italy.

The principal components analysis (Figure 2) and the discriminant analysis (Figure 3) show three well distinct groups across the populations studied. The cases correctly classified by discriminant analysis according to the groups assigned a priori were 91.4%.

Molecular characterisation

A total of 71 SSR alleles were identified across the 10 loci (Table 2) in 35 dwarf palm genotypes and all individuals were differentiated. Locus37 showed the highest

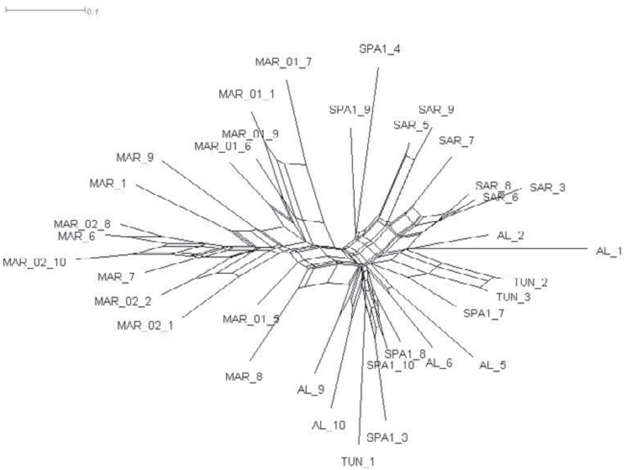

Figure. 5. Split tree of 35 *Chamaerops humilis* genotypes of five putative populations based on Nei and Li's genetic distance. MAR: Terketen, Morocco; MAR1: Beni Mellal, Morocco; MAR2: Touama, Morocco; SPA: Valencia, Spain; ALG: Sidi Belattar, Algeria; TUN: Cap Serrat, Tunisia; SAR: Porto Tangone, Sardinia, Italy.

Table 2. SSR locus name, number of alleles (No), observed (Ho) and expected heterozygosities(He), polymorphic information content (PIC) of 10 microsatellite loci in a sample of 35 accessions of *Chamaerops humilis*.

Locus name	Allele No	H exp	Ho	PIC
locus19	6	0,64	0,36	0,55
locus25	12	0,84	0,44	0,8
locus27	9	0,85	0,47	0,82
locus15	5	0,63	0,58	0,57
locus16	3	0,5	0,36	0,43
locus23	3	0,26	0,14	0,25
Locus35	6	0,65	0,83	0,58
Locus37	16	0,9	0,72	0,88
Locus44	4	0,58	0,97	0,49
Locus48	7	0,83	0,55	0,79
Mean	7,1	0,668	0,542	0,62

number of observed alleles per locus (16) while locus16 and locus23 the lowest (3); the average number of alleles per locus was 7.1. Seven SSR markers were found highly informative (PIC > 0.5) and three reasonably informative (0.25 < PIC < 0.5); PIC average was 0.62.

For eight SSR loci the expected heterozygosity (He) was higher than the observed heterozygosity, except for locus35 and locus44, which deviated from Hardy Weinberg equilibrium. Mean He resulted 0.67 and the mean Ho was 0.54.

Interestingly, a rare allele of 97 bp at the locus37 was found restricted to two genotypes from Terketen (MAR1 and MAR8). Neighbor-Net method cluster analysis (Figure 5) showed that the Moroccan genotypes separated from all genotypes of the other geographical areas. Overall genotypes from Beni Mellal presented an intermediate genetic proximity with other populations. Two genotypes MAR6 and MAR7 from Terketen showed closer relationship with Touama genotypes. Algerian, Sardinian, Spanish, and Tunisian genotypes shared closer relationships and genotypes from Sardinia grouped together.

DISCUSSION

The large intrapopulational morphological variation observed testifies a large genetic variability among the studied populations. This variation was proven by the molecular analysis.

A rich assortment of SSR alleles was found indicating a greater genetic diversity than that previously identified on 705 Sicilian dwarf palm genotypes using 28 SSR markers (Giovino *et al.* 2014). This information is useful for acquiring new knowledge on the species and for planning a more extensive work on the whole area of distribution of this species in order to acquire a more detailed knowledge to preserve *Chamaerops humilis* genetic diversity in the future.

As concern the presence of a rare allele restricted to some genotypes of the Terketen population, it is possible to speculate that this allele may reflect an adaptation to particular environment conditions or stresses. It has been shown in many species that SSR diversity is adaptive, influenced by natural and anthropic selection and correlated with ecological-edaphic and genetic factors (Marchese *et al.* 2010, Marchese *et al.* 2017). Natural selection plays an essential role in controlling the length of a repeat (Li *et al.* 2000). King and Soller (1999) proposed that changes in length of SSRs functionally integrated into the genome can influence plant adaptive fitness. However, further molecular studies are needed, including a greater number of genotypes representative of all dwarf palm populations, to confirm the uniqueness of this allele.

In the Neighbor-Net cluster analysis the Moroccan genotypes grouped together and appeared separated from Algerian, Sardinian, Spanish, and Tunisian genotypes which seemed to share closer relationships, among this latter group the Sardinian genotypes grouped jointly. In general, the Neighbor-Net cluster analysis was in agreement with the discriminant analysis.

According to the observed variability, it seems opportune to distinguish the populations of high altitude of Atlas and Anti-Atlas as a distinct subspecies.

A careful bibliographic research has allowed us to ascertain that the name *Chamaerops humilis* var.

argentea André Rev. Hort. 57: 231 (1885) quoted by the large part of repertoires and floras (e.g. Maire 1957, Fennane 2014) has never been published either in that place or, as far as we have been able to verify, in other sources. So, the first validly published name that can refer to this entity is *C. humilis* var. *cerifera* Becc. described on material cultivated in Naples of dubious origin. The study of original material housed in FI, where the Herbarium by Beccari is housed (Cuccuini and Nepi 2006) was not sufficient to dispel the doubts because the single specimen found (Beccari n. 384) consists only of badly preserved fruits. In any case the only known populations in nature with grey leaves, due to the high concentration of waxes on their surface, are found exclusively in Morocco at high altitudes, thus the taxon described by Beccari, by reasonable assumption, refers to these populations.

The following new combination is proposed:

Chamaerops humilis subsp. ***cerifera*** (Becc.) Giovino & Domina subsp. nov. (≡*C. humilis* var. *cerifera* Becc. in Webbia 5(1): 65 1921).

Type: Lectotype (here designated): Beccari n. 384, *Chamaerops humilis* L. v. *cerifera* Becc.; Italia, Napoli, n. 1919, Ruffo, ex Ruffo principe di S. Antimo (FI).

This subspecies differs from *C. humilis* subsp. *humilis* by its leaves glaucous-silvery, dull, covered with persistent scaly hairs. The individuals in form of compact tufts with short stems and smaller leaves blades commonly found in high altitude populations in High Atlas and Anti Atlas are due to the effect of environmental and anthropozoogenic degradation.

CONCLUSION

The obtained results agree with those by García-Castaño *et al.* (2014): *C. humilis* has a large morphological and genetic variation throughout its distribution range. The southern populations from Morocco are isolated from the resting ones and in particular high-altitude populations are well distinct from the morphological and genetic points of view due to a speciation underway moved by ecological and spatial separation to which they are subjected. Thus, it is here proposed to discriminate these populations within a separated subspecies.

These results encourage about the possibility of cultivating *Chamaerops humilis* subsp. *cerifera* also in environments with lower temperatures than the Mediterranean coasts where *C. humilis* subsp. *humilis* has been confined so far. Such cultivations would have primary interest as ornamental but the possibility of extraction of medicinal principles is not excluded.

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Supplemental Data file 1. Mean of the measures on morphological characters used for statistical analysis.

Code	Population	Height of the stem (cm)	Height of the plant (cm)	Crown diameter (cm)	Stem diameter (mm)	Petiole width (cm)	Petiole width (cm)	Leaf length (cm)	Leaf width (cm)	Leaf thickness (mm)	No. of leaf segments	No. thorns on the petiole	Wax coverage density %
MAR_1	Terketen, Morocco	7,5	17	27	34,5	3,9	3,2	8,7	11,8	1	9	0	95
MAR_2	Terketen, Morocco	8	20	22	29,9	3,1	3,5	9,7	13,7	0,8	8	5	95
MAR_3	Terketen, Morocco	6	20	28	28,6	0,9	4,1	11,5	14	0,8	9	8	95
MAR_4	Terketen, Morocco	4,5	15,5	19	34,5	0,8	3,3	9,5	11	0,7	10	1	95
MAR_5	Terketen, Morocco	9	19	24	47,5	3,3	2,7	8,8	10,6	0,5	9	2	95
MAR_6	Terketen, Morocco	6	20	21	29,4	4,2	4,2	12,7	15,5	1,1	9	0	95
MAR_7	Terketen, Morocco	6	26,5	31	23,8	3,7	6	13,6	17,7	0,7	11	4	95
MAR_8	Terketen, Morocco	8	20	23	31,5	3	4,7	10,3	13	0,9	11	0	95
MAR_9	Terketen, Morocco	11,5	29	36	34,5	3,4	6	11,3	15	0,8	11	6	95
MAR_10	Terketen, Morocco	9,5	22	24	20,5	3,2	3,7	9,4	10,5	0,5	8	9	95
MAR_11	Terketen, Morocco	7	18,5	26	34,9	3,3	5	9	11,5	1,2	9	10	95
MAR_12	Terketen, Morocco	7,5	23	30,5	34,9	3,9	4,5	10,2	13,2	0,9	11	7	95
MAR_13	Terketen, Morocco	8	21,5	28	27,3	2,7	3,2	9	10,5	0,4	9	4	95
MAR_14	Terketen, Morocco	6	16	20	31,7	3,2	2,7	5,2	10,7	0,7	9	4	95
MAR_15	Terketen, Morocco	8	20	21	29,5	2,9	2,8	11,4	13,7	0,8	10	5	95
MAR_16	Terketen, Morocco	7,5	23	24	26,2	3,1	2,7	10	10,2	0,4	9	11	95
MAR_17	Terketen, Morocco	8	22,5	26,5	34,8	2,5	4,4	10,7	10,1	0,5	9	1	95
MAR_18	Terketen, Morocco	9	21	29,2	34,2	3,1	4,3	9,7	8,5	0,7	8	3	95
MAR_19	Terketen, Morocco	4	12	16	33,5	2,8	2	6,5	9,5	0,5	7	15	95
MAR_20	Terketen, Morocco	8	21	32	34,4	3,9	4,5	9,8	12,2	1	10	5	95
MAR_21	Terketen, Morocco	6,5	27,5	32	33,4	3	9,5	14,3	19,2	0,5	9	9	95
MAR_22	Terketen, Morocco	8	21,5	30	38,5	3,1	4,2	9,5	10,2	0,4	9	13	95
MAR_23	Terketen, Morocco	10	25	31	28,2	3	5,5	12,3	14,5	0,5	11	12	95
MAR_24	Terketen, Morocco	6	2,6	30,5	35,4	3	4,5	10,5	13,2	0,5	10	12	95
MAR_25	Terketen, Morocco	10	23,5	35,5	44,8	2,6	4,7	10	14,8	0,5	10	6	95
MAR_26	Terketen, Morocco	4	21	23	27,8	3	3,8	9,7	13,2	0,6	9	1	95
MAR_27	Terketen, Morocco	6	20	29,5	30,1	3,5	4,8	10,2	13,8	0,6	9	11	95
MAR_28	Terketen, Morocco	7	21	29	24,1	3,1	3,7	9,5	14	0,6	9	7	95
MAR_29	Terketen, Morocco	4	20	30	24,4	2,7	5	12,3	16,8	0,6	8	4	95
MAR_30	Terketen, Morocco	9	22	28,5	34,2	3,4	5,3	12	15,2	0,8	11	7	95
MAR_31	Terketen, Morocco	6	24	34,5	29,8	3,3	6,3	12,3	14,2	0,8	8	11	95
MAR1_1	Beni Mellal, Morocco	4	20	30	14,3	3,8	2	16,8	11	0,9	4	5	55
MAR1_2	Beni Mellal, Morocco	4	17	31	26,5	4,6	4	15	14	0,8	10	6	55
MAR1_3	Beni Mellal, Morocco	3,5	17,5	29	4,3	3,7	2,3	16,7	12,7	0,7	5	3	55
MAR1_4	Beni Mellal, Morocco	4	15	20	16,4	4	2,2	12	12,3	1	7	5	65
MAR1_5	Beni Mellal, Morocco	3	15,5	17	16	3,3	2,7	10,3	9	0,6	6	5	65
MAR1_6	Beni Mellal, Morocco	4	14	17	20	3,5	2	10,2	9,3	1,3	7	3	65
MAR1_7	Beni Mellal, Morocco	4	14	17	20	2,5	1,5	9	6	0,6	6	0	65
MAR1_8	Beni Mellal, Morocco	3,5	21,5	41	20	3,4	5,3	16,3	12	0,7	6	6	55
MAR1_9	Beni Mellal, Morocco	4	14,5	23	24	1,2	3,2	11,7	8	0,8	5	0	55
MAR1_10	Beni Mellal, Morocco	5	18,5	25	18,3	3,5	3,2	15,2	12,3	0,8	11	5	65
MAR1_11	Beni Mellal, Morocco	2	12,5	21	17	3,3	2,8	12,2	8	0,7	7	3	75
MAR1_12	Beni Mellal, Morocco	3	18	18	23	3,9	2,2	13,7	9	0,9	6	3	65
MAR1_13	Beni Mellal, Morocco	3	19	25	18	3,8	3	14,5	9	0,7	6	6	75
MAR1_14	Beni Mellal, Morocco	4	16,5	24	19	3,5	2,9	12,6	9	0,9	6	3	55
MAR1_15	Beni Mellal, Morocco	4	17,5	23	17,5	3,3	2,6	11	9,3	0,9	5	3	55

Code	Population	Height of the stem (cm)	Height of the plant (cm)	Crown diameter (cm)	Stem diameter (mm)	Petiole width (cm)	Petiole width (cm)	Leaf length (cm)	Leaf width (cm)	Leaf thickness (mm)	No. of leaf segments	No. thorns on the petiole	Wax coverage density %
MAR1_16	Beni Mellal, Morocco	3	18	22	23	3,6	2,9	13	9,2	0,7	7	5	65
MAR1_17	Beni Mellal, Morocco	3	16,5	20	17	3,8	3,2	12,8	9,2	0,7	6	3	65
MAR1_18	Beni Mellal, Morocco	3,5	16	24	23	3,7	2,9	12,5	8,7	0,9	6	3	76
MAR1_19	Beni Mellal, Morocco	3	17	23	23	2,9	3,2	16	12,5	0,7	6	5	65
MAR1_20	Beni Mellal, Morocco	4	15	26	21	3,6	4	16	13,5	0,9	6	3	55
MAR1_21	Beni Mellal, Morocco	4	15,5	25	18	3,5	3,6	17	13,2	0,6	7	3	65
MAR1_22	Beni Mellal, Morocco	3,5	16,5	19	23	3,2	2,8	12,7	8,3	0,7	6	5	76
MAR1_23	Beni Mellal, Morocco	3	18	25	18,5	3	3,1	15,1	12	0,9	6	3	65
MAR1_24	Beni Mellal, Morocco	5	19	24	19	2,9	2,7	12	9,8	0,9	6	5	65
MAR1_25	Beni Mellal, Morocco	4	18	19	19	3,3	3,5	16,6	13,2	0,6	7	0	55
MAR1_26	Beni Mellal, Morocco	3,5	17,5	23	18	3,5	3,4	17,2	13	0,7	6	5	65
MAR1_27	Beni Mellal, Morocco	4	18	24	18,5	3,6	3,3	12	8,2	0,9	5	3	65
MAR1_28	Beni Mellal, Morocco	3,5	18,5	22	21	3	4	15,5	13,8	0,7	6	5	75
MAR1_29	Beni Mellal, Morocco	4	17	20	22	2,9	2,8	14	12,6	0,9	6	3	55
MAR1_30	Beni Mellal, Morocco	3	18	24	23	3,4	3	13,7	8,9	0,8	7	3	65
MAR1_31	Beni Mellal, Morocco	4	17	24	26	3,6	2,7	12	10,3	1,1	7	3	55
MAR2_1	Touama, Morocco	3	17,5	25	20	3,4	3,5	14,3	10,7	0,4	7	0	55
MAR2_2	Touama, Morocco	3	13	15	19	3,1	2,2	10,5	8	0,4	7	0	65
MAR2_3	Touama, Morocco	3	16	16	22	2,8	2,3	12,7	10,7	0,7	6	0	75
MAR2_4	Touama, Morocco	3	15	18	16	3,6	2,7	11,7	12,7	0,7	9	0	75
MAR2_5	Touama, Morocco	4	14	20	12	3,6	2,7	10,3	10	0,9	6	0	75
MAR2_6	Touama, Morocco	3	17	23	12	2,6	5,3	13,7	10	0,7	7	0	65
MAR2_7	Touama, Morocco	5	14	10	25	2,3	3	8,7	6	1,4	5	0	55
MAR2_8	Touama, Morocco	4	16	22	20	2,6	3	12,6	10,8	0,6	6	0	55
MAR2_9	Touama, Morocco	4	17	23	22	2,7	3,1	13,5	10	0,7	5	0	65
MAR2_10	Touama, Morocco	3	17	18	18	2,6	2,8	10,5	9,6	0,9	7	0	55
MAR2_11	Touama, Morocco	3	18	22	20	3	2,9	11,9	12,5	0,6	6	0	65
MAR2_12	Touama, Morocco	5	16	23	22	2,6	4	12,7	10,7	0,7	5	0	75
MAR2_13	Touama, Morocco	4	16	18	20	2,8	2,8	12	10	1	7	0	55
MAR2_14	Touama, Morocco	3	17	20	18	2,8	2,7	10,7	9,8	0,6	5	0	65
MAR2_15	Touama, Morocco	3	17	23	22	3	3	13,5	9,5	0,7	6	0	55
MAR2_16	Touama, Morocco	5	18	20	18	4	2,8	11,9	9	0,9	7	0	75
MAR2_17	Touama, Morocco	5	17	18	20	2,8	3	12,7	10,5	1	6	0	65
MAR2_18	Touama, Morocco	4	16	22	25	2,8	3	10,8	9,8	0,6	5	0	75
MAR2_19	Touama, Morocco	4	17,5	23	23	3,1	2,7	12,2	9,6	0,7	6	0	55
MAR2_20	Touama, Morocco	3	18	22	22	3	2,6	13,1	8,7	1	7	0	65
MAR2_21	Touama, Morocco	3	17	20	19	2,8	2,9	12,7	10,7	0,9	6	0	75
MAR2_22	Touama, Morocco	3	18	20	21	4	3,1	12,2	10,5	0,6	6	0	55
MAR2_23	Touama, Morocco	4	17,5	22	20	2,6	2,5	13,4	9	0,7	7	0	65
MAR2_24	Touama, Morocco	5	16	23	20	3	2,6	9,6	7	0,9	6	0	75
MAR2_25	Touama, Morocco	4	16	22	18	2,8	2,7	12,4	10,7	0,6	6	0	55
MAR2_26	Touama, Morocco	3	14	24	20	3,2	2,8	11,3	10,3	0,6	5	0	75
MAR2_27	Touama, Morocco	3	15	21	22	3,2	4,2	13,7	10	0,7	6	0	55
MAR2_28	Touama, Morocco	5	15,5	20	19	2,8	3,2	15	11,4	0,7	7	0	75
MAR2_29	Touama, Morocco	4	17,5	20	21	2,9	3,6	15,3	10,5	0,6	6	0	55
MAR2_30	Touama, Morocco	4	17	22	22	3	3,6	12,8	10,5	0,9	7	0	55
MAR2_31	Touama, Morocco	3	17	18	19	2,6	3	13	11,7	0,7	7	0	65

Code	Population	Height of the stem (cm)	Height of the plant (cm)	Crown diameter (cm)	Stem diameter (mm)	Petiole width (cm)	Petiole width (cm)	Leaf length (cm)	Leaf width (cm)	Leaf thickness (mm)	No. of leaf segments	No. thorns on the petiole	Wax coverage density %
ALG1	Sidi Belattar, Algeria	7,5	29	31	19,8	3,6	7,3	21,3	18,3	0,7	8	8	25
ALG2	Sidi Belattar, Algeria	7	25,5	41	25,1	3,8	6,2	21,7	19,7	0,6	10	8	25
ALG3	Sidi Belattar, Algeria	7	23	27	19,8	3,9	5	15	16	0,9	7	8	25
ALG4	Sidi Belattar, Algeria	6,5	22,5	24,5	21	3,7	6	18,3	14,2	0,8	5	6	25
ALG5	Sidi Belattar, Algeria	6	26	32,5	24	3,3	7,2	21,5	15,2	0,6	6	6	25
ALG6	Sidi Belattar, Algeria	2,5	25,5	35	14,3	3,8	6,7	24,2	8,3	0,4	4	7	25
ALG7	Sidi Belattar, Algeria	3,5	21	29	12	3,9	5,2	20,7	12,2	0,8	6	7	25
ALG8	Sidi Belattar, Algeria	4	22	37	19,2	4,2	6,2	20,7	11,3	0,8	7	7	25
ALG9	Sidi Belattar, Algeria	4	18	31	12,3	3,8	2,2	16	7,3	0,9	4	2	30
ALG10	Sidi Belattar, Algeria	7	28	41	24,6	3,2	6	22	10,3	0,8	6	7	35
ALG11	Sidi Belattar, Algeria	5	18	27	13,8	3,4	4	14,5	8,7	0,5	7	6	35
ALG12	Sidi Belattar, Algeria	5	20	26	29,1	3,1	10	3,8	6,8	0,5	10	4	35
ALG13	Sidi Belattar, Algeria	7	18	28	21,7	3,7	5,2	19,2	5,3	0,8	6	5	45
ALG14	Sidi Belattar, Algeria	8	29,5	34	35,4	3,6	7,7	19,3	13,7	0,7	12	13	45
ALG15	Sidi Belattar, Algeria	3	22	38	19,5	3,9	4,8	8,7	8,3	0,9	7	8	45
ALG16	Sidi Belattar, Algeria	6	30	33	14,8	3,1	5,8	20,3	7,3	0,7	4	5	45
ALG17	Sidi Belattar, Algeria	5	23	30	23	3,2	4,7	15	10,7	0,6	7	1	45
ALG18	Sidi Belattar, Algeria	5	21	29	34,3	3,1	5,5	15,8	11,7	1,3	7	5	45
ALG19	Sidi Belattar, Algeria	7	16	26,5	26	4	3,8	12,7	7	0,6	9	4	45
ALG20	Sidi Belattar, Algeria	5,5	27,5	30	14,5	3,5	5,2	21	7,2	0,6	7	6	45
ALG21	Sidi Belattar, Algeria	4	20	30	25	3,9	4,5	16	9,8	0,8	7	2	45
ALG22	Sidi Belattar, Algeria	4,5	20	28	24,8	3,6	6	17,2	14,8	1	8	4	45
ALG23	Sidi Belattar, Algeria	5,5	28,5	33,5	17,3	3,5	6,2	22	12,3	1	5	6	45
ALG24	Sidi Belattar, Algeria	4	22	30	12,4	4	6,5	20	6	0,8	7	9	45
ALG25	Sidi Belattar, Algeria	5	28	28	15,7	3,7	6,2	18,2	9,7	0,9	6	5	45
ALG26	Sidi Belattar, Algeria	7	23	39	25,8	4,3	5,3	21,8	14,3	0,7	8	8	35
ALG27	Sidi Belattar, Algeria	4	21	24	31	4,4	3,3	14,5	8	1,2	6	4	35
ALG28	Sidi Belattar, Algeria	4	26	31	16,2	5,2	2,7	17	16	0,7	9	3	35
ALG29	Sidi Belattar, Algeria	6	20	25	20,5	4,1	3,7	11,8	11,7	1,1	10	3	35
ALG30	Sidi Belattar, Algeria	5	25	29	15,8	3,8	4,5	19,7	8	0,8	8	3	35
ALG31	Sidi Belattar, Algeria	6	21	36	20,3	3,6	5,7	17,2	12,8	0,5	6	7	35
SPA1	Valencia, Spain	6,5	24	27,5	23,6	4,1	5,2	16	16,2	1,6	9	7	35
SPA2	Valencia, Spain	4	28	29,5	15,3	3,7	7,2	23	24,5	0,9	6	11	35
SPA3	Valencia, Spain	3,5	30	34	13,1	3,5	5,7	29	19,3	1,2	6	7	35
SPA4	Valencia, Spain	3	21	24	16,9	4,3	3,3	16	18	2,8	6	5	35
SPA5	Valencia, Spain	6	24	32	18,8	4,4	4,3	19,5	15	1,8	4	7	35
SPA6	Valencia, Spain	5	20,5	24	18,4	3,1	6,7	19,2	18,2	2	7	8	35
SPA7	Valencia, Spain	2,5	20,5	24	13,5	4,1	3,5	14,7	12,8	0,9	5	5	35
SPA8	Valencia, Spain	4	27	27	14,2	4,4	4,8	23,7	9,7	1,9	4	4	30
SPA9	Valencia, Spain	6	29,5	25	29,3	3,8	4,7	19,2	15,8	1,3	5	7	25
SPA10	Valencia, Spain	3,5	27	30	19,3	3,4	7	19,7	16	2	6	9	25
SPA11	Valencia, Spain	4,5	26	29,3	18,5	3,8	7,8	22,2	15	1,5	7	11	25
SPA12	Valencia, Spain	4	24,5	30	23	3,8	7,5	20,7	16	1,3	7	10	25
SP13	Valencia, Spain	5,5	28,5	24	21,7	4,7	5,7	5,8	14	1,6	7	11	25
SPA14	Valencia, Spain	4	35	39	33,8	6,2	7,8	26	24	2,3	9	11	25
SPA15	Valencia, Spain	4	23	26	21,7	2,9	4,3	17	10	1,4	7	7	35
SPA16	Valencia, Spain	4	27,5	33	20,1	4,3	6,5	19	15,8	1,7	7	10	35

Code	Population	Height of the stem (cm)	Height of the plant (cm)	Crown diameter (cm)	Stem diameter (mm)	Petiole width (cm)	Petiole width (cm)	Leaf length (cm)	Leaf width (cm)	Leaf thickness (mm)	No. of leaf segments	No. thorns on the petiole	Wax coverage density %
SPA17	Valencia, Spain	4,5	27	20,5	22,2	4,2	4,7	17,5	14,7	0,9	8	6	35
SPA18	Valencia, Spain	4	21	28,5	22,3	4,9	4,5	17,7	20,7	1,6	8	11	35
SPA19	Valencia, Spain	3,5	21,5	27	22,5	4,3	4,7	15,5	14,3	1,6	7	7	35
SPA20	Valencia, Spain	2,5	20,5	24	13,2	4,1	2,2	16	11,7	1,4	6	3	35
SPA21	Valencia, Spain	3,5	20	24,5	15,4	5,4	2,3	15,7	12	1,1	6	3	35
SPA22	Valencia, Spain	3,5	18	23	14,5	5,1	2,5	13,5	13	1,3	7	2	35
SPA23	Valencia, Spain	5	22,5	26	17,3	3,9	2,8	19,2	14,5	1,3	6	8	35
SPA24	Valencia, Spain	5	28	28	19,1	4,2	7	22,3	14,3	1,4	7	11	35
SPA25	Valencia, Spain	3	30	29,5	18	5,4	4,5	23,2	14,2	1,7	6	3	35
SPA26	Valencia, Spain	4	33	36	12,6	4,3	6,7	27,7	22,5	2,5	6	10	35
SPA27	Valencia, Spain	4	25,5	26	17	4,5	5,5	20	11,8	1,5	6	3	35
SPA28	Valencia, Spain	3	28	23	11	3,7	5,7	19,5	13,2	0,9	7	8	35
SPA29	Valencia, Spain	3,5	26,5	21	12,8	4,1	6	16,3	11,8	0,9	7	6	35
SPA30	Valencia, Spain	4	27	25,5	13,4	3,8	5,8	13,3	12,2	0,7	6	10	35
SPA31	Valencia, Spain	3	27,5	22	11,5	3,4	5,5	12,5	12,2	1	5	7	35
TUN1	Cap Serrat, Tunisia	3	31	33,5	20,3	4,2	8,3	27,3	23	0,8	7	8	25
TUN2	Cap Serrat, Tunisia	4	41	46	33,5	4,3	11,7	30	20	0,6	7	11	25
TUN3	Cap Serrat, Tunisia	2	24.5	22	17,7	3,6	2,3	16,3	11,8	1,2	4	0	25
TUN4	Cap Serrat, Tunisia	2	16	26	18,1	3,7	3	13	11,3	1,3	7	0	25
TUN5	Cap Serrat, Tunisia	2	18	28	20,6	4,7	3,3	16,3	16,3	0,8	10	5	25
TUN6	Cap Serrat, Tunisia	6	36,5	43	20,2	4,3	5,8	22,2	22	0,9	9	11	25
TUN7	Cap Serrat, Tunisia	5	28,5	32	22,8	3,9	6,7	20,3	10	0,6	8	7	25
TUN8	Cap Serrat, Tunisia	7	37,5	38	27,5	5	11,3	25,8	25,7	0,7	10	10	25
TUN9	Cap Serrat, Tunisia	4,5	27,5	34	18	5,1	8,8	24,8	15,7	1	5	5	25
TUN10	Cap Serrat, Tunisia	6,5	35	38	36	5,9	10,5	24,2	17,7	1	11	11	25
TUN11	Cap Serrat, Tunisia	5	30,5	40	22	4,3	8,2	26,8	19	0,5	9	7	25
TUN12	Cap Serrat, Tunisia	5	22	35	16,4	3,8	3,2	17,8	13,7	0,7	5	1	25
TUN13	Cap Serrat, Tunisia	3	23	37	16,7	3,7	5,2	21,3	8	0,7	3	0	25
TUN14	Cap Serrat, Tunisia	6	32	41,5	28,8	4,9	8,3	24,5	18	0,8	9	8	25
TUN15	Cap Serrat, Tunisia	6,5	33	34	20	4,2	6,5	24,2	12	0,7	4	5	25
TUN16	Cap Serrat, Tunisia	6	26,5	26	20,1	3,9	4,2	18,2	11,7	0,6	5	3	25
TUN17	Cap Serrat, Tunisia	6,5	47	56	32,3	4,8	12,7	31	23,7	1,7	12	10	25
TUN18	Cap Serrat, Tunisia	10	43	48	42	5,3	11,3	33,3	21,3	1	8	9	25
TUN19	Cap Serrat, Tunisia	7	38	41	28,3	4,7	7,7	22,7	15	0,7	6	10	25
TUN20	Cap Serrat, Tunisia	9	46,5	50	47	5,4	15,8	31,7	23	0,9	10	11	25
TUN21	Cap Serrat, Tunisia	7	44	45	38,3	4,6	12	25,8	22,3	1	10	12	25
TUN22	Cap Serrat, Tunisia	11	54,5	60	42,5	5,6	18	38,3	20,7	0,7	12	11	25
TUN23	Cap Serrat, Tunisia	7,5	38	43	35	4,8	8,7	16,3	25	1,1	10	7	25
TUN24	Cap Serrat, Tunisia	8	49,5	45	38	6	12,7	38,3	14	1,1	8	7	25
TUN25	Cap Serrat, Tunisia	6	41	49	28,1	5,2	12,8	31,8	13	1,5	5	9	25
TUN26	Cap Serrat, Tunisia	7	30	33	30	4,2	6,7	19,3	15,7	1,1	6	7	25
TUN27	Cap Serrat, Tunisia	7,5	38	44	44,2	5,1	12	27,3	10	1,1	9	7	25
TUN28	Cap Serrat, Tunisia	5,5	35	37	23	4,4	7,8	26,2	15	0,7	4	8	25
TUN29	Cap Serrat, Tunisia	7	38,5	50	34,4	6	14,8	32,2	20	1,4	12	12	25
TUN30	Cap Serrat, Tunisia	5	31	40	19	4,4	5,7	23	12	1,3	6	9	25
TUN31	Cap Serrat, Tunisia	3	27	34	16	3,4	5,5	24	11	1	3	3	25
SAR1	Porto Tangone, Sardinia	10	29,5	30	16	4,8	4,3	14	16,5	3,7	8	6	25

Code	Population	Height of the stem (cm)	Height of the plant (cm)	Crown diameter (cm)	Stem diameter (mm)	Petiole width (cm)	Petiole width (cm)	Leaf length (cm)	Leaf width (cm)	Leaf thickness (mm)	No. of leaf segments	No. thorns on the petiole	Wax coverage density %
SAR2	Porto Tangone, Sardinia	3	19	22	11,5	3,1	2,7	12,5	9,5	2	4	1	25
SAR3	Porto Tangone, Sardinia	4,5	20,5	24	16,8	4,5	2,8	14,8	15,2	5	9	7	25
SAR4	Porto Tangone, Sardinia	4	22	12,5	12,5	4	1,3	17,7	9	4,3	5	0	35
SAR5	Porto Tangone, Sardinia	2,5	18,5	14	9,8	3,9	1	10,8	8,3	3,4	4	0	35
SAR6	Porto Tangone, Sardinia	5,5	21	21,5	12,7	3,6	2,3	12,8	10,2	5,7	5	5	35
SAR7	Porto Tangone, Sardinia	3,5	21	27,5	12,9	3,4	2,7	13,7	15,7	4,7	8	3	35
SAR8	Porto Tangone, Sardinia	3,5	20,5	26,5	14,8	3,9	2,7	15,5	15,8	9,3	5	0	30
SAR9	Porto Tangone, Sardinia	5	26	23	15,9	3	4	16	13,7	3,2	3	5	25
SAR10	Porto Tangone, Sardinia	4	26	27,5	23,8	3,9	4,5	16,7	17,3	4,3	11	5	25
SAR11	Porto Tangone, Sardinia	3	22,5	29,5	10,6	3	3,3	16,3	13,3	3,5	5	3	30
SAR12	Porto Tangone, Sardinia	4,5	28	26	18,5	4,8	5,3	19,8	17	3,7	8	7	35
SAR13	Porto Tangone, Sardinia	5	25	26,5	17	3,8	3,8	20	12,5	4,7	8	5	30
SAR14	Porto Tangone, Sardinia	4	32	27,5	9,9	4,5	4,5	22	13,7	4,5	5	3	35
SAR15	Porto Tangone, Sardinia	4,5	30	27,5	16,9	4,7	4,2	21,3	13	5,6	3	5	25
SAR16	Porto Tangone, Sardinia	6	27	23	22	3,8	3,6	18,9	14,3	4,7	5	3	25
SAR17	Porto Tangone, Sardinia	5	25	27,5	21,8	3,9	4,1	19,1	15	4,3	4	0	30
SAR18	Porto Tangone, Sardinia	4,5	19	26,5	10,7	4,5	4,5	22	13,6	4,7	8	5	30
SAR19	Porto Tangone, Sardinia	4	32	27,5	16,7	4,7	4,1	20,6	14,7	5,5	5	3	35
SAR20	Porto Tangone, Sardinia	6	22	27,5	10,4	3,8	3,8	17,3	11,6	4,7	5	3	40
SAR21	Porto Tangone, Sardinia	5	27	23	18,4	4	4,2	14,1	8,9	4	4	0	30
SAR22	Porto Tangone, Sardinia	4,5	25	27,5	16,9	4,5	4,5	16,3	15,4	5,6	5	3	25
SAR23	Porto Tangone, Sardinia	4	19	26,5	23	4,3	3,8	22,2	13,4	4,5	4	5	30
SAR24	Porto Tangone, Sardinia	6	31	19	17,5	3,8	3,6	19,5	16,2	4,7	5	5	35
SAR25	Porto Tangone, Sardinia	4	22	27,5	16,9	4,2	4,5	22,6	15,3	4,3	3	3	25
SAR26	Porto Tangone, Sardinia	4,5	24	26,5	20,3	4,5	4,2	19,4	16,3	4	4	0	30
SAR27	Porto Tangone, Sardinia	5	28	27,5	18,6	3,9	3,8	19,2	16,2	4,7	8	5	35
SAR28	Porto Tangone, Sardinia	3,5	31	23	17,5	3,8	3,6	22	14	3,8	5	0	30
SAR29	Porto Tangone, Sardinia	6	24	26,5	18,3	4,5	4,5	21,6	15,8	4,1	4	3	25
SAR30	Porto Tangone, Sardinia	5,5	28	23	17,4	4,1	4,1	23	15,8	4,6	5	5	30
SAR31	Porto Tangone, Sardinia	7	22	23	15,8	3,9	3,7	9,8	13,3	3,4	8	4	35

Supplemental data file 2. Pearson correlation coefficients (r) among the 12 characters measured. All correlations were significant with p > 0.0001 (Student's t test) with the lone exception of Leaf thikness.

	H stem	H plant	Crown diameter	Stem diameter	Petiole width	Petiole length	Leaf length	Leaf width	Leaf thikness	No. leaf segments	No. thorns	Hair density
H stem		3,42E-08	1,82E-08	3,39E-23	0.048467	1,14E-07	0.079418	1,98E-01	0.24308	7,31E-13	3,29E-06	0.0058902
H plant	0.4303		1,55E-41	7,09E-02	4,91E-22	9,76E-52	2,97E-45	1,70E-21	0.0277	0.0065374	1,04E-14	3,97E-13
Crown diameter	0.45465	0.77937		1,41E-06	7,02E-14	6,31E-52	3,46E-31	2,11E-15	0.18042	1,34E-02	2,91E-18	1,30E-04
Stem diameter	0.64769	0.29956	0.4178		0.3676	7,78E-10	0.44561	0.0001304	4,70E-02	3,28E-20	2,50E-03	9,37E-03
Petiole width	0.13412	0.63638	0.54079	0.061459		3,93E-12	9,67E-23	9,64E-12	6,58E-01	0.14084	5,07E-06	9,39E-19
Petiole length	0.4396	0.82722	0.82799	0.47882	0.51553		4,07E-33	8,69E-17	0.082782	4,18E-04	2,50E-19	7,00E-05
Leaf length	0.11934	0.79836	0.71441	0.052045	0.64331	0.72809		5,46E-16	0.013342	0.39458	3,73E-06	1,16E-26
Leaf width	0.28525	0.63096	0.56117	0.25682	0.49385	0.57859	0.55578		0.0043571	6,97E-04	1,80E-12	5,84E-03
Leaf thikness	-0.079577	0.14947	-0.091265	-0.30507	0.26751	-0.11803	0.16776	0.19284		5,25E-01	0.14078	2,41E-05
No. leaf segments	0.52635	0.1841	0.32128	0.61759	0.1003	0.36163	-0.058079	0.35603	-0.27094		2,85E-05	1,18E-02
No. thorns	0.41007	0.53844	0.59605	0.34151	0.38371	0.60805	0.40892	0.52061	-0.10031	0.38944		0.0071865
Hair density	0.18638	-0.53018	-0.37405	0.32569	-0.60164	-0.38043	-0.67882	-0.33146	-0.39111	0.32287	-0.182	