Flora Montiberica 41: 3-9 (I-2009). ISSN 1138-5952

A NEW WILD HYBRID IN *LAVATERA* (MALVACEAE)

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ABSTRACT: A new nothotaxon *Lavatera* × *columbretensis* Juan & M.B. Crespo is described from the Columbretes Archipelago (E of Spain). Several morphological features (e.g. pedicel, epicalyx and corolla length) assessed the existence of individuals morphologically intermediate between *L. arborea* and *L. mauritanica* subsp. *davaei*. Statistical analyses (PCA) supported segregation of three different groups, corresponding to both cited species and the new hybrid. The current hybridization process could be explained as a direct consequence of the strong isolation of that peculiar island habitat. **Key words:** *Lavatera*, islands, hybridization, Spain.

RESUMEN: Se describe un nuevo nototaxon, *Lavatera* × *columbretensis* Juan & M.B. Crespo, del archipiélago de las Columbretes (E de la Península Ibérica). Diversas características morfológicas (e.g. longitud del pedicelo, del epicáliz y de la corola) revelan la presencia de individuos híbridos. Los análisis estadísticos (PCA) apoyan la existencia de tres grupos claros, que corresponderían a *L. arborea*, *L. mauritanica* subsp. *davaei*, y al nuevo híbrido. Este proceso de hibridación podría considerarse como una consecuencia directa del marcado aislamiento de este hábitat insular. **Palabras clave:** *Lavatera*, islas, hibridación, España.

INTRODUCTION

The Malvaceae family comprises several examples of introgression and hybridization on well known genera such as *Hibiscus* or *Gossypum* (MENZEL & WILSON, 1963; BRUBAKER & al., 1999 among others). However, these events of natural hybridization are not so common in other genera such as *Lavatera*. In the Iberian flora, FERNANDES (1993) only indicated the presence of hybrid individuals between *L. olbia* L. and *L. triloba* L. However, natural hybrids appeared to be more frequent in the close genus *Malva* (cf. FERNANDES, 1993).

The taxa *Lavatera arborea* L. and *L. mauritanica* Durieu subsp. *davaei* (Cout.) Cout. belong to *L.* sect. *Anthema* (Medik.) DC., which is mainly characterised by star-shaped hairs and seeds hidden by the pericarps. The former shows a wide distribution along the littoral Spanish territories (including islands), whereas the latter presents isolated and reduced coastal populations in the eastern and southern parts of the Iberian Peninsula (FENANDES, 1993).

These two taxa show well-developed natural populations in the volcanic archipelago of Columbretes, due to the climatic and ecological features together to the remarkable isolation of these particular islands. Both *Lavatera* grow on soils strongly nitrified by depositions ("guano") of sea-birds, mainly *Larus audouinii* and *L. cachinnans*. However, both *Lavatera* taxa do not show the same pattern of

distribution in Columbretes archipelago. *L. mauritanica* subsp. *davaei* grows only in two islands (Grossa and Mancolibre), whilst *L. arborea* appears in most of the archipelago (Grossa, Mancolibre, Ferrera and Foradada islands). Preliminary field studies undertaken on the mixed populations of Grossa and Mancolibre islands revealed the existence of some individuals that did not match morphologically with those cited taxa. In fact, they showed some intermediate features quite easy to detect by visual inspection.

The present paper shows the results of a comprehensive morphometric study of the three entities (*Lavatera arborea*, *L. mauritanica* subsp. *davaei* and the hybrids individuals). Main morphological features have been characterized, and data have been analysed using principal component analysis (PCA).

MATERIAL AND METHODS

The fieldwork has been carried out in the Marine Reserve of the Columbretes Archipelago (Valencian Community, E of Spain). These islands are volcanic, with a dominant halo-nitrophilous perennial vegetation (JUAN & CRESPO, 1999). The present study was carried out in both Grossa and Mancolibre islands, the only two islets where *L. arborea* and *L. mauritanica* subsp. *davaei* live together.

Although the phylogenetic boundaries between *Malva* and *Lavatera* are not fully resolved (RAY, 1995; FUERTES-AGUILAR & al., 2002), we have treated them as independent, following indications by BAYER & KUBITZKI (2003) in the most recent, complete and widely accepted account of the family. The specific taxonomical treatment accords that by FERNANDES (1993), though some doubts still exist with regard to the position of the subspecies of *L. mauritanica*. Morphological observations were based on living and dried plants from Columbretes islands. Nevertheless, we also added measures of individuals from other Iberian localities where *L. arborea* and *L. mauritanica* subsp. *davaei* show isolated populations, in order to characterise morphologically pure individuals (see Appendix). The studied materials are kept at ABH, MA and VAB herbaria (HOLMGREN & al., 1990; HOLMGREN & HOLMGREN, 1993). Diverse qualitative and quantitative features were studied for each specimen (Table 1). A principal component analysis (PCA) was performed using all quantitative characters to explore morphological variation and assess the main morphological differences. It was conducted with the software SSPS v. 14.

RESULTS

All *Lavatera* taxa showed clear morphological differences, which are mainly based on floral characters (Table 1). These features allow easy recognition of living and, also, of dried plants. The hybrid plants appeared to be morphologically different from both parents, as regards mainly to floral features such as flower and pedicel length, together to flowering and fruiting epicalyx length. Some of the quantitative features showed a tendency to be closer to *L. mauritanica* subsp. *davaei* in some individuals. Therefore, morphological differentiation between them was somewhat problematic in some points of Columbretes. Nevertheless, the hybrid individuals are well characterised by the main erect stem 50-60 mm diameter, and up to 2 m high being closer to *L. arborea* (Table 1).

Regarding the PCA analysis (Figure 1), three principal components were obtained with a total variance of 73.0%. The two first components revealed a 46.8% and 16.6% of the variance, respectively. Factor structure coefficients for the first

Flora Montiberica 41: 3-9 (I-2009). ISSN 1138-5952

two factors are shown in Table 2. The first principal component revealed the existence of three groups, of which *L. arborea* and *L. mauritanica* subsp. *davaei* constituted the extremes whereas the new hybrid individuals nested in an intermediate position. This analysis clearly showed that some floral (e.g. flower length, pedicels and epicalyx segments) or fruit characters (e.g. number of mericarps) are of paramount importance to separate among the three *Lavatera* taxa (Table 2). Moreover, a discriminant analysis was also performed (data not shown) that revealed the same basic pattern found in PCA.

To conclude, 3 taxa of *Lavatera* can be differentiated currently in Columbretes archipelago, of which one shows a hybrid origin and no name appears to be available for it. Therefore, it is here described as new, honouring the Columbretes archipelago, the land where it was discovered:

Table 1: Diagnostic morphological features among the three *Lavatera* taxa.

Characters	*L. arborea*	*L.* × *columbretensis*	*L. mauritanica* subsp. *davaei*
HABIT	Biennial, perennial up to 2 m high	Biennial, perennial up to 2 m high	Annual-Biennial up to 1 m high
FLOWER			
Floral pedicel length	10-22	5-12	3-6
Flower length	18-30	14-19	12-17
Epicalyx length (flower)	6-13	5-9	3-4
Epicalyx length (fruit)	10-17	7-11	6-9
Epicalyx lobes shape	suborbicular	suborbicular, subovate	oblong or subovate
STIPULE			
Length	4-8	4-7	5-7
Type	deciduous	persistent	persistent
MERICARP			
Nº of mericarps	6-8	8-10	8-10
Size (L × W)	3.5-4.0 × 2.8-3.3	3.1-4.0 × 2.1-3.6	2.6-3.9 × 1.9-3.7
Dorsal face width	2.3-3.1	3.1-3.8	2.5-3.7
SEEDS			
Length	2.7-3.1	2.6-3.1	2.5-3.7

Lavatera* × *columbretensis Juan & M.B. Crespo ***nothosp. nov***. nothosubsp. ***columbretensis*** [*L. arborea* L. × *L. mauritanica* Durieu subsp. *davaei* (Cout.) Cout.]

Holotype: ESP, CASTELLÓN**:** Islas Columbretes, Isla Grossa, Casernas, 31SCE0219, 40 m, 18-III-1996, *A. Juan* (ABH 42556).

Diagnosis: A *L. arborea* differt floribus minoribus; stipulis persistentibus; pedicellis floralibus brevioribus (ad 12 mm); calyculo fructifero calycem non superante; mericarpiis plus numerosis (8-10 vice 6-8), ruguloso-reticulatis hispidisque. A *L. mauritanica* subsp. *davaei* differt habitu bienni vel perennanti; caule elatiore, ad 170 cm alt.; pedicellis floralibus longioribus; flores longiores; calyculo suborbiculato quam calycem aequilongiore; mericarpiis majoribus (3.1-4 × 2.1-3.6 mm).

It is necessary to point out that *Lavatera arborea* and *L. mauritanica* subsp. *davaei* also live together in other localities of southern Iberian Peninsula and northern Africa (BOLÒS & VIGO, 1984; FERNANDES, 1993), and therefore this nothotaxon should not be restricted to the Columbretes islands, and it could be found in other similar coastal habitats.

DISCUSSION

The present study demonstrates the existence of morphological patterns of variation in the *Lavatera* population in Columbretes archipelago. The most common and numerous populations are conformed by these hybrids, in both Grossa and Mancolibre islands. Particularly, the hybrid individuals are clearly dominant and even the unique *Lavatera* individuals in certain areas of Grossa island (e.g. Casernas, Monument, etc.). The long time isolation of these volcanic islands could favour a current crossing process between *L. arborea* and *L. mauritanica* subsp. *davaei* and, hence, the establishment of the hybrid population. Moreover, the small size of those islands (Grossa 13.3 hectares, and Mancolibre 0.1 hectares), together with the effectiveness of pollinators, could facilitate pollen exchange (ELLSTRAND & ELLAN, 1993). Wild plant hybridization is a widely detected process in other islands (BROCHMANN & al., 2000).

Some authors have pointed out potential problems with the use of morphological data in hybridization analysis (RIESEBERG, 1995), though the use of these tools is usually considered as the first evidence of hybridization or introgression (HAWKINS & al., 1999). Nevertheless, new studies are needed to ascertain the evolutive input of the hybridization process of this *Lavatera* complex in Columbretes. Cytogenetic, reproductive and molecular studies should be achieved (JUAN & al., in prep.). Information about chromosome numbers of the putative hybrid would be quite informative since its parents show different counts (FERNANDES, 1993). Molecular markers could also help to infer the current genetic variability of the Columbretes populations in relation to other continental population, and those data could assess the existence of eventual introgression process in the archipelago. Therefore, further investigations are still needed to fulfil those points.

Acknowledgements: We are indebted to the Park wardens of the Marine Reserve of the Columbretes archipelago for their assistance during the field work. The authors thank J. Jiménez, J. V. Escobar and the Castellón council for their support and facilities to stay in Columbretes archipelago. The curators of the cited herbaria are also kindly thanked for the loan of plant material.

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(Received 8-XII-2008)

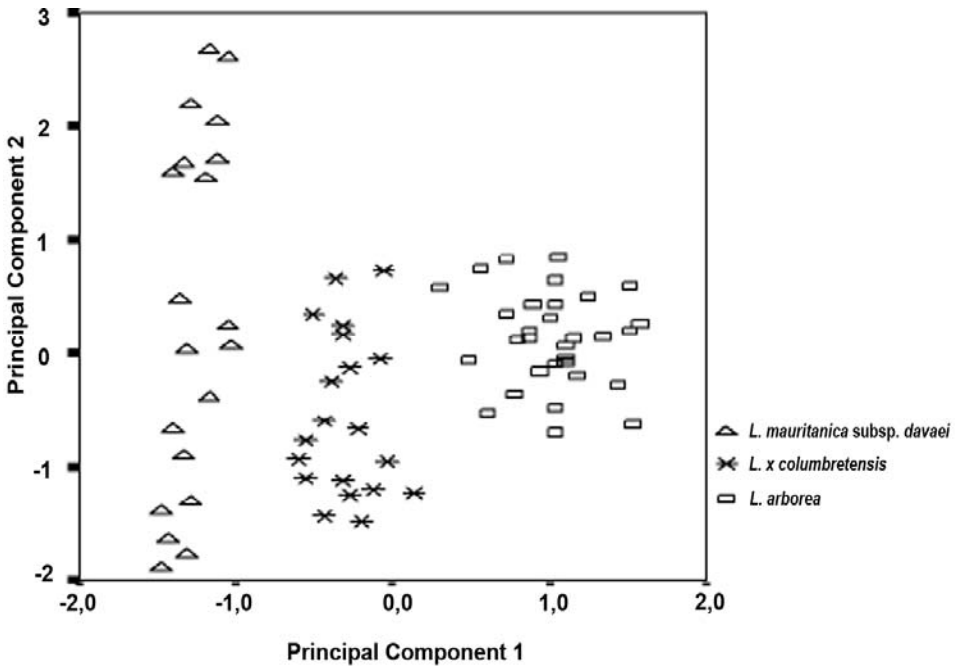

Figure 1: Principal component analysis (PCA) based on morphological data of *Lavatera* taxa. The first two components explain 46.8% and 16.6% of variation, respectively.

Table 2: Factors loadings in PCA for the morphological quantitative variables

(L = length; W = width; CV= cumulative variables).

Variable	PC1	PC2
L flower	0.884	0.105
L floral pedicel	0.892	-0.037
L flowering epicalyx	0.933	-0.014
L fruiting epicalyx	0.872	-0.069
L stipules	-0.243	-0.731
Nº mericarps	-0.846	-0.057
L mericarp	0.370	0.051
W mericap	0.391	0.594
W dorsal face	0.556	-0.377
L seed	-0.325	0.781
Eigen values	4.68	1.66
CV (%)	46.85	63.49

APPENDIX: STUDIED MATERIAL

Lavatera arborea L., Sp. Pl.: 690 (1753)

SPAIN. **Alicante**: Gorga, Barranc de Cosí, pr. del pueblo, 30SYH28, 520 m, 10-V-1992, *L. Serra* (ABH3421). Benidorm, Sierra Helada, 30SYH5470, 40 m, 16-V-1992, *Solanas, M.B. Crespo & De la Torre* (ABH 4326). Elche, La Marina, 30SYH02, 0 m, 14-III-1993, *E. Camuñas* (ABH 6753). Villena, 30S XH8175, 500 m, 6-IV-1994, *M.A. Alonso* (ABH 8334). Petrer, Sª del Cid, 30SXH9561, 440 m, 10-IV-1994, *A. Juan et al*. (ABH 8430). La Romana, Sª del Reclot, 30SXH8348, 420 m, 7-III-1996, *A. Navarro* (ABH 17452). Ibíd., ibíd., Cavafría, 30SXH8151, 550 m, 6-V-1995, *A. Navarro* (ABH 17790). Torrellano, 1-IV-1960, *A. Rigual* (ABH 21101). Villajoyosa, en los campos de cultivo, 10-V-1975, *A. Rigual* (ABH 21103). Alicante, campos prox. Sierra de los Tajos, 30SYH0957, 210 m, 20-IV-1998, *E. Camuñas & J.C. Cristóbal* (ABH 39062). Alfaz del Pi, Sierra Helada, arenas, 30SYH5570, 20 m, 5-IV-1998, *A. Ruiz de León, L. Rull & J.C. Cristóbal* (ABH 39583). Guardamar del Segura, 30SYH0618, 3 m, 17-VI-1998, *A. Ruiz de León* (ABH 39934). Alicante, Sierra Grossa, 30SYH2249, 50 m, 24-III-1999, *E. Camuñas, J.C. Cristóbal & M. Fabregat* (ABH 41626). Xàbia, L'Escull del Cap, 31SBC5698, 10 m, 15-VI-2000, *A. Ros, A. Barber, J. Piera, M.B. Crespo & Cristóbal* (ABH 44039). Vall de Laguart, Benimaurell, 30SYH5095, 500 m, 28-III-1999, *M.B. Crespo, Cristóbal, A. Juan, M. Fabregat & E. Camuñas* (ABH 44181). Jávea, Escull del Cap, 31SBC5698, 10 m, 12-III-2001, *A. Juan & M.B. Crespo* (ABH 45053). La Torre, Barranc de la Torre, 30SYH2377, 850 m, 20-IV-1991, *L. Serra* (VAB 931629). Jávea, BC5794, herbazales litorales ruderales, 20-IV-1992, *V.J. Arán & M.J. Tohá* (MA 509154). **Bilbao**: Bermeo, Isla de Izaro, 30TWP2508, 35 m, 18.VII-1983, *C. Aseginolaza, D. Gómez & G. Montserrat* (ABH 40427). **Castellón**: Islas Columbretes, Isla Mancolibre, 31SCE0219, 8 m, 10-IV-1996, *A. Juan* (ABH 30557). Ibíd., Columbrete Grande, Faro, Lad. N, 31SCE0219, 55 m, 13-IV-1994, *M.B. Crespo & L. Serra* (ABH 30558). Ibíd., ibíd., Casernas, 31SCE 0219, 40 m, 13-IV-1994, *M.B. Crespo & L. Serra* (ABH 30559). Ibíd., Isla La Ferrera, 31SCE0018, 20 m, 14-III-1995, *A. Juan* (ABH 30560). Ibíd., Isla La Horadada, 31SCE0016, 30 m, 17-III-

1994, *M.B. Crespo & L. Serra* (ABH 30561). Ibíd., Isla Foradada, 31SCE0016, 30 m, 8-III-1994, *M.B. Crespo & L. Serra* (ABH 42550). Ibíd., Isla Ferrera, 31S CE01, suelo volcánico muy nitrificados, 5-IV-1982, *M. Beltrán, S. Castroviejo 6206, F. Muñoz & G. Stübing* (MA 326679). **Granada**: Almuñecar, Cerro Gordo, ruderal, 30SVF36, 100 m, 8-III-1979, *Molero Mesa* (MA 319033). **Valencia**: Serra, 30SYJ2096, 300 m, 4-III-1987, *M.B. Crespo* (ABH 2890).

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≡ *L. davaei* Cout. *in* Bol. Soc. Brot. 11: 122 (1893)

SPAIN. **Alicante**: Alicante, Tabarca, Islita de La Galera, 16-IV-1965, *Rigual* (ABH 20797). Ibíd., ibíd., Islote de la Galera, 30SYH2126, 2 m, 8-IV-1998, *E. Camuñas & M.B.Crespo* (ABH 38415). Ibíd., ibíd., en *Chenopodietea* (ut *L. punctata* All.), 16-IV-1965, *Rigual* (MA 373484). Ibíd., ibíd., 30SYH2127, 5 m, 8-IV-1998, *E. Camuñas & M.B. Crespo* (ABH 38428). Ibíd., ibíd., Islote de la Nao, 30SYH 2227, 3 m, 8-IV-1998, *E. Camuñas & M.B. Crespo* (ABH 38559). **Almería**: Cuevas del Almanzora, Playa del Pozo del Esparto, 30S XG1633, 2 m, 14-IV-2005, *M.B. Crespo, A. Juan, M. Soler & J.C. Cristóbal* (ABH 48574). **Cádiz**: Tarifa, silíceo, 26-V-1967, *A. Segura*, (MA 361406). Ibíd., in deep sand almost at water's edge, amongst rocks, where straits of Gibraltar meet Atlantic ocean, 5-VI-1974, *Molesworth Allen* (MA 205012). **Castellón**: Islas Columbretes, Illa Grossa, 31SCE0219, 45 m, 26-V-1995, *A. Juan* (ABH 42551). Ibíd., ibíd., 31SCE0219, 75 m, 25-V-1995, *A. Juan* (ABH 42552). Ibíd., ibíd., 31SCE0218, 23 m, 13-III-1995, *A. Juan* (ABH 42553). Ibíd., ibíd., 31SCE0219, 20 m, 16-III-1995, *A. Juan* (ABH 42554). Ibíd., ibíd., 31SCE0219, 40 m, 13-IV-1994, *M.B. Crespo & L. Serra* (ABH 42555). Ibíd., Isla Mancolibre, 31SCE 0219, 8 m, 10-IV-1996, *A. Juan* (ABH 42567). Ibíd., Illa Grossa, Casernas, 31S CE0219, 22 m, 13-III-1995, *A. Juan* (ABH 42556).

PORTUGAL. Algarve: Aljezur, Ponta da Atalaia, 29SNB13, 130 m, 15-IV-1996, *Camuñas, Juan, Serra, Cristóbal & Crespo* (ABH 30988). Sagres, Cabo de São Vicente, 29S NA09, 120 m, 16-IV-1996, *Camuñas, Juan, Serra, Cristóbal & Crespo* (ABH 31117). Ibíd., 29SNA09, 100 m, *in sabulosis rupestri busque calcareis ad ora maris*, 26-III-1978, *Fernández Casas, Molero, Muñoz Garmendia, Pajarón & Pujadas* (MA 410751, VAB 92/0631). Punta de Sagres, arenoso calizo, 20-IV-1968, *A. Segura* (MA 361468). Non detailed province (ut *L. africana* var. *daveaui*, cult. ex vern me Daveau deht), *C. Pau* (MA 77020).

Lavatera* × *columbretensis Juan & M.B. Crespo, ***nothosp nov.***

SPAIN. Castellón: Islas Columbretes, Illa Grossa, 31SCE0219, 22 m, 13-III-1995, *A. Juan* (ABH 42557). Ibíd., ibíd., 31SCE0218, 20 m, 13-III-1995, *A. Juan* (ABH 42558). Ibíd., ibíd., Casernas, 31SCE0218, 20 m, 13-IV-1994, *M.B. Crespo & L. Serra* (ABH 42559). Ibíd., ibíd., Faro, ladera N, 31SCE 0219, 55 m, 13-IV-1994, *M.B. Crespo & L. Serra* (ABH 42560). Ibíd., ibíd., 31SCE0218, 40 m, 14-III-1995, *A. Juan* (ABH 42561). Ibíd., ibíd., Casernas, 31SCE 0219, 40 m, 13-IV-1994, *M.B. Crespo & L. Serra* (ABH 42562). Ibíd., ibíd., ibíd., 31SCE0219, 22 m, 13-III-1995, *A. Juan* (ABH 42563). Ibíd., ibíd., 31SCE0219, 18 m, 10-III-1995, *A. Juan* (ABH 42564). Ibíd., ibíd., Faro, ladera N, 31SCE0219, 55 m, 13-IV-1994, *M.B. Crespo & L. Serra* (ABH 42565). Ibíd., ibíd., entre cementerio e Imagen, 31SCE0218, 45 m, 14-III-1995, *A. Juan* (ABH 42566). Ibíd., Isla Mancolibre, 31SCE0219, 8 m, 10-IV-1996, *A. Juan* (ABH 42568).