Anales del Jardín Botánico de Madrid 71(2): e011 2014. ISSN: 0211-1322. doi: http://dx.doi.org/10.3989/ajbm.2338

Taxonomical identity of *Sarcocornia fruticosa* and *S. hispanica* in the Iberian Peninsula

Ana Guilló[1]*, M Ángeles Alonso[1], M. Lucía Lendínez[2], Carlos Salazar[2] & Ana Juan[1]

[1]Instituto de la Biodiversidad-CIBIO. Universidad de Alicante. PO Box 99. E-03080. Alicante. Spain
[2]Dpto. Biología Animal, Biología Vegetal y Ecología. Campus Las Lagunillas s/n. Universidad de Jaén. E-23071. Jaén. Spain
ana.guillo@ua.es; lulendi@ujaen.es; csalazar@ujaen.es; ana.juan@ua.es

Abstract

Guilló, A., Alonso, M.A., Lendínez, M.L., Salazar, C. & Juan, A. 2014. Taxonomical identity of *Sarcocornia fruticosa* and *S. hispanica* in the Iberian Peninsula. *Anales Jard. Bot. Madrid* 71(2): e011.

The recent description of *Sarcocornia hispanica*, from SE Iberian Peninsula evidences the notable morphological complexity of this genus. This species is quite close to *S. fruticosa*, as they both show an erect habit and lack of rooting stems. Besides, *S. fruticosa* has been traditionally recorded for the same geographical area of *S. hispanica*. However, the original description of *S. hispanica* did not include any mention about these two taxa would live together and which ones are the differential morphological characters. Our study aims to clarify their main morphological differences and to address two questions. Firstly, if two close species would be coexisting or secondly, if both species would not live together and then only one erect shrubby species should be recognised for the southeastern peninsular. Therefore, a detailed morphological study of these two species was carried out using vegetative and reproductive characters together with SEM features. Based on the original description, the main morphological features of *S. hispanica* were compared, plus other features which would support their identification. Our data pointed out the existence of a marked overlapping for most of the studied characters independently of the geographical procedence of the samples. As a result, no significant morphological differences have been found between both taxa, and *S. hispanica* is proposed as a mere synonym of *S. fruticosa*.

Keywords: Morphological study, chromosome number, SEM, Spain, Portugal.

Resumen

Guilló, A., Alonso, M.A., Lendínez, M.L., Salazar, C. & Juan, A. 2014. Identidad taxonómica de *Sarcocornia fruticosa* y *S. hispanica* en la Península Ibérica. *Anales Jard. Bot. Madrid* 71(2): e011.

La reciente descripción de *Sarcocornia hispanica*, para el sureste de la península ibérica, evidencia la notable complejidad morfológica de este género. Esta especie es muy próxima a *S. fruticosa*, ya que ambas tienen el hábito erecto y carecen de ramas enraizantes. Además, *S. fruticosa* ha sido tradicionalmente citada para la misma área geográfica de *S. hispanica*. Sin embargo, en la descripción original de *S. hispanica* no se indica si ambos taxones conviven y tampoco se aportan los caracteres morfológicos que los diferencian. El presente trabajo se centra en clarificar sus principales diferencias morfológicas, y dar respuesta a dos posibles hipótesis. En primer lugar, si estas dos especies coexisten, o en segundo lugar, ambas especies no convivirían y solo una especie arbustivas de hábito erecto, se reconocerían para el sureste peninsular. Para ello, se ha realizado un estudio morfológico detallado de ambas especies basado en diferentes caracteres vegetativos y reproductivos, junto con características obtenidas con MEB. Se han comparado los principales caracteres morfológicos indicados en la descripción original de *S. hispanica*, así como otros caracteres que apoyen la identificación de ambos taxones. Los datos obtenidos indican que la mayor parte de las características analizadas están solapadas entre ambas especies con independencia de su procedencia geográfica. Por tanto, no se han encontrado diferencias morfológicas entre ambos taxones, y se propone a *S. hispanica* como un sinónimo de *S. fruticosa*.

Palabras clave: Estudio morfológico, número cromosomático, MEB, España, Portugal.

INTRODUCTION

The genus *Sarcocornia* (L.) A.J. Scott (Amaranthaceae) is a markedly complex genus as has been reported by many authors (Castroviejo & Coello, 1980; Castroviejo & Lago, 1992; Shepherd & Yan, 2003; Kadereit & al., 2006; Alonso & Crespo, 2008), and a large number of synonyms is recognized due to its taxonomical difficulty (Maire & Quézel, 1962; Quézel & Santa, 1963; Meikle, 1977; Pignatti, 1982; Bolòs & Vigo, 1990; Ball, 1993; Coste, 2007; Guilló & al., 2011). The marked halophytic behaviour of *Sarcocornia* species favours the development of similar morphological traits, which makes quite difficult to distinguish species, and even other related genera (e.g. *Arthrocnemum* (Moric.) K. Koch, *Salicornia* L.). In this framwork, many authors have questioned the taxonomical identity of two closely related genera such as *Sarcocornia* and *Salicornia* on the basis of a lack of differential morphological features (Freitag, 1989; Kühn & al., 1993; López-González, 1997). In addition, the existence of hybridization phenomena between *Sarcocornia* taxa has been also reported for several populations of the Iberian Peninsula, contributing to obscure the filed (Castroviejo & Lago, 1992; Luque & al., 1995; Figueroa & al., 2003).

Two species of *Sarcocornia* are widely accepted to be present in the Iberian Peninsula and other adjacent Mediterranean territories (Greuter & al., 1986). Both specie are characterised by shrubby habit, opposite leaves fused to form a segment and spicate inflorescences with each fertile segment composed by 3-flowered cymes. The first one *Sarcocornia fruticosa* (L.) A.J. Scott can be recognized by erect and no rooting stems, with a seminal exotesta covered by papillae or short conic hairs with a wide base (Castroviejo, 1990; Guilló & al., 2012). This species, described by Linnaeus (1753), was typified on material from the Camargue in France (Ball, 2007). The second species, *Sarcocornia perennis* (Mill.) A.J. Scott, is distinguished by its creeping habit, with marked rooted branches and by a seminal exotesta covered by long and usually hooked hairs (Castroviejo, 1990; Guilló & al., 2012). This species was described by Miller (1768) from Sheppey Island (United Kingdom), and typified on material from the same locality (cf. Guilló & al., 2011). Additionally, a taxon related to *S. perennis*, *S. alpini* (Lag.) Rivas Mart. was described from

* Corresponding author.

southwestern territories (Cádiz province) of the Iberian Peninsula, (cf. Lagasca, 1817), though it is mostly considered under an infraspecific taxonomical range as *S. perennis* subsp. *alpini* (Lag.) Castrov. (Castroviejo, 1990). The separation between both subspecies are based on differences their habit and width of the inflorescence (Castroviejo & Coello, 1980; Castroviejo, 1990). For the time being, this infraspecific taxon has been mentioned to occur in other Mediterranean territories as Morocco, Portugal and Italy (Valdés & al., 2002; Molero & Monserrat, 2006; Costa & al., 2009; Biondi & al., 2010). Recently, a new taxon named *S. hispanica* Fuente & al. with an explicit distribution in the Murcian-Almeriensian, Betic and Mediterranean Central Iberian and Balearic-Catalan-Provençal biogeographic provinces (Fuente & al., 2011). Fuente & al. (2011) described this species as a shrub with erect and ascending branches, not rooting stems, characterized by a fused or partially fused pericarp to the seed and by a verrucate seminal exotesta covered with papillae. According to their diagnosis and in the absence of a comparative analysis by Fuente & al. (2011), *S. fruticosa* would be considered as the closest morphological taxonomic relative, since both taxa share many morphological features (e.g. habit, seminal coat ornamentation). Moreover, since *S. hispanica* occurs in part of the recorded distribution area of *S. fruticosa* in south-eastern Iberian territories, apparently *S. fruticosa* and *S. hispanica* overlapp in their geographical area of distribution, (Álvarez Rogel, 1997; Alonso & de la Torre, 2002; Salazar & al., 2002; Fuente & al., 2011; Lendínez & al., 2011). As a consequence, the taxonomical identity of the *Sarcocornia* taxa, occurring in south-eastern Iberian territories, should be carefully reviewed as two mutually ecluding scenarios may apear: (i) either *S. hispanica* and *S. fruticosa* are two sympatric species which can grow together; or (ii) only one species characterised by an erect habit should be recognised and the consideration of *S. fruticosa* as a separate species results from a taxonomical misinterpretation. The main goal of this study is centred on clarifying the taxonomical identity of the southeastern Iberian *Sarcocornia* populations based on morphological comparative analyses between the two closest taxa: *S. hispanica* and *S. fruticosa*. Moreover, a nomenclature review has been carried out regarding to *S. fruticosa* in order to clarify the different used taxonomical denominations.

MATERIAL AND METHODS

Sampling

A total of 45 populations distributed in 29 localities (L) around the western Mediterranean basin and Atlantic surrounding areas were studied (Fig. 1). Localities include from one to five populations. From the 45 populations, 40 correspond to *S. fruticosa* populations, and five populations traditionally considered as *S. fruticosa* but here referred as *S. hispanica* according to Fuente & al. (2011). The specific details of these populations are provided in Appendix 1. All studied plant material is mostly kept at the Herbarium of the University of Alicante (ABH, acronym according to Thiers, 2012). The type material of *S. hispanica* was also analysed (kept in MAF herbarium), but in the case of *S. fruticosa*, only the photographical material has been observed since the original type material could not be directly studied due to its conservation status (Ball, com. pers.). Besides, specimens from other herbaria (G, MA, MAF, VAL and W) were studied (see appendix 2). Besides, fresh material was particularly studied from the type localities of *S. hispanica* (Villena, Spain) and *S. fruticosa* (Camargue, France), which is kept at ABH.

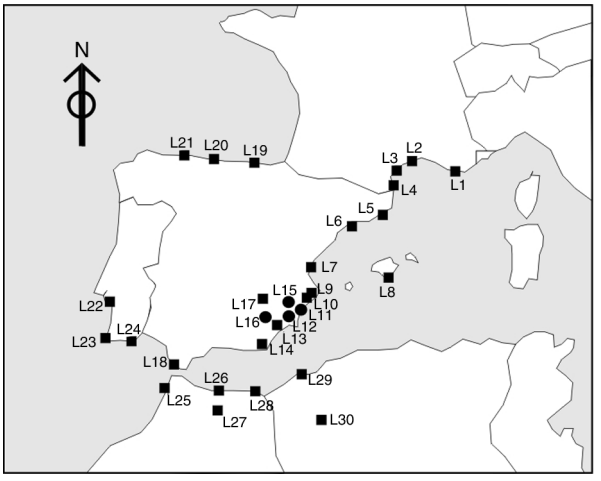

Fig. 1. Map of the studied populations. The squares correspond to *Sarcocornia fruticosa* populations and the circles to *Sarcocornia hispanica* populations.

Morphological study

A comparative morphological study was performed based on characters used in the literature to identify the species of the genus *Sarcocornia* (Valdés & al., 1987b; Castroviejo, 1990; Shepherd & al., 2005; Alonso & Crespo, 2008; Guilló & al., 2012), with a focus on those remarked for the identification of *S. hispanica* (Fuente & al., 2011). Three types of moprhological characters were selected. First, morphological vegetative characters: The habit, height of the plant and the presence/absence of rooting branches have been directly observed in the field. The size of vegetative segments was measured on five segments per individual and five individuals per population with maximum and minimum values are provided. The shape of the segments and their apical apexes were also observed on these same individuals. These latter observations were done using an optical binocular (Olympus SZX12) with micrometer.

A second set of morphological reproductive characters was included, those were: The size of terminal and lateral inflorescences (length×width) was measured in five individuals per population. Besides, total number of lateral spikes was also counted. Maximum and minimum values are provided. The fruit description is provided according to Font Quer (1989). The morphological relationship between the pericarp and the perianth was based on the suggestions done by Shepherd & al. (2005). Features related to seed shape, colour and seminal orientation were observed on three seeds per sample and population. These observations were done using an optical binocular (Olympus SZX12) with micrometer.

And finally a thrid group of micromorphological characters was studied by light and SEM microscopy in several

structures.The seminal coat, stomata and pollen were studied using dried material. Seminal coats were observed on three seeds per sample and population. The features related to seed size (length×width), type of indumentum and shape of the trichomes were analysed using scanning electronic microscope (SEM) images. No special treatment was required prior to SEM observations. Samples were directly glued on metallic stubs, and then coated with about 30 nm gold for 5-10 minutes. Minimum and maximum values are provided for seed measurements. Stomatal morphology was studied using the vegetative segments according to Guilló & al. (2012). Pollen was also studied for six individuals from five localities (L2, L12, L14, L15, L19) using light microscope (Olympus SX 212) and SEM. The morphological nomenclature for seeds and stomata follows to Guilló & al. (2012), whereas pollen nomenclature was based on Valdés & al. (1987a).

Chromosome number

Samples from the southeastern Iberian populations of Laguna Salada de La Mata (Torrevieja, Alicante) and Salinas del Braç del Port (Santa Pola, Alicante) were analysed. We have followed the protocol proposed by Day & al. (2012), though with certain modifications due to the small genome of the genus *Sarcocornia* (Koce & al., 2008). Chromosomes were observed using a microscope Axioplan 2 (Carl Zeiss, Göttingen, Germany). The pictures were taken with a camera SPOT RT (Diagnostic Instruments, Inc., Sterling Heights, MI, USA) using the software SPOT ST v. 4.0.4 (Diagnostic Instruments).

RESULTS

Morphological vegetative characters values are summarized in Table 1. Habit is always erect for all the studied samples, independently of their taxonomical denomination. The height of *S. fruticosa* ranges from 50 to 180 cm high. This maximum value was observed in many samples from the salty soils of the river Antas (Almería, Spain). Besides, the plant height is 50-100 cm in the type population of *S. fruticosa*. In the case of *S. hispanica*, the samples show a similar range (50-100 cm), which is totally coincident with the obtained measures from the type population of this taxon.

In all the studied populations, adult plants do not develop rooting branches, since branches are mostly erect. Nonetheless, certain young branches of punctual young and short individuals would appear lied directly on the soil, and consequently, adventitious roots could be sporadically originated. This rare growth pattern should not be considered as the typical rooting habit defined for other related species as *S. perennis*, which always show rooting branches independently of the age of the branch and the sample (pers. obs.).

The apex of the vegetative segment is generally obtuse, rarely rounded, and their shape is constantly obconic independently of their geographical origin. These vegetative segments measured 2.0-18.0×1.5-3.0 mm for *S. fruticosa*, which were 2.0-7.0×1.5-2.5 mm for its type population. In *S. hispanica* populations, vegetative segments showed equal values (2.0-18.0×1.5-3.0 mm), though they were somehow smaller in its type locality (3.5-5.0×1.5-2.5 mm).

Morphological reproductive characters (Table 2)

Inflorescences. They are always branched being characterized by a terminal and several non-pedunculate lateral spikes. The thickness of the spikes was 2.0-4.0 mm for both species, independently of their geographical origin. The length of the spikes was also rather similar between both species and among all the populations (including the type localities). The obtained length range for *S. fruticosa* was 10-45 mm, whereas it was 11-45 mm for *S. hispanica*. The number of lateral spikes was 6-40 for *S. fruticosa*, being this range smaller in the type locality of the Camargue population (10-26 lateral spikes). Similar data were obtained for the populations of *S. hispanica* (14-40 lateral spikes), and its type population (10-28 lateral spikes).

Fruit. The fruit corresponds to an utricule, since it is dry, monosperm and dehiscent. Besides, its pericarp always appears totally jointed to the perianth, which becomes membranous. Subsequently, the seed remains inside this perianth-pericarp structure and partly protrudes being possible to be observed. Seeds can be mostly separated without difficulty from the perianth-pericarp structure, though some pericarp residues would remain adhered on the seed surface, and they are rather difficult to separate. This relationship between perianth-pericarp and seed has been widely observed for both *S. fruticosa* and *S. hispanica*.

Seeds. Seeds are always brownish and their shape varies from ovate to orbiculate, without any tendency between the studied species. The seminal orientation was vertical in relation to the ovary position. The size for *S. fruticosa* and *S. hispanica* populations (including the type localities) was 0.63-1.50×0.52-1.02 mm and 0.93-1.37×0.69-0.85 mm, respectively.

Table 1. Morphological vegetative characters studied for *S. hispanica* and *S. fruticosa*. For *S. hispanica*, data from their original diagnosis (Fuente & al., 2011), from the natural type population (Las Virtudes, Spain) and natural populations recognised as *S. hispanica* according to Fuente & al. (2011) are provided. For *S. fruticosa*, data from its type location (Camargue, France) and other Mediterranean populations are exposed

	S. hispanica			*S. fruticosa*	
Characters	**Original diagnosis**	**Population of Las Virtudes (L14)**	**Other populations (L11, L12, L16)**	**Population of Camargue (L2, L3, L4)**	**Other Mediterranean populations**
Habit and branches	Erect, not rooting	Erect, not rooting	Erect, not rooting	Erect, not rooting	Erect, not rooting
Plant height (cm)	100-150	50-100	50-100	50-100	50-180
Segment shape	No data	Obconic	Obconic	Obconic	Obconic
Segments size (mm)	No data	3.5-5×1.5-2.5	2.0-18.0×1.5-3.0	2.0-7.0×1.5-2.5	2.0-18.0×1.5-3.0
Segment apex shape	Subacute to rounded	Obtuse to rounded	Obtuse to rounded	Obtuse to rounded	Obtuse to rounded

Table 2. Reproductive characters studied for *S. hispanica* and *S. fruticosa*. For *S. hispanica*, data from their original diagnosis (Fuente & al., 2011), from the natural type population (Las Virtudes, Spain) and natural populations recognised as *S. hispanica* according to Fuente & al. (2011) are provided. For *S. fruticosa*, data from its type location (Camargue, France) and other Mediterranean populations are exposed

	S. hispanica			*S. fruticosa*	
Characters	**Original diagnosis**	**Population of Las Virtudes (L14)**	**Other populations (L11, L12, L16)**	**Population of Camargue (L2, L3, L4)**	**Other Mediterranean populations**
Number of lateral spikes	No data	10-28	14-40	10-26	6-40
Presence of terminal and lateral spikes	Yes	Yes	Yes	Yes	Yes
Spike length (mm)	No data	16.0-45.0	11-45	25.0-31.0	10-45
Spike width (mm)	2.0-3.0	2.0-3.5	2.0-4.0	2.0-3.0	2.0-4.0
Fruit	Achene	Utricle	Utricle	Utricle	Utricle
Pericarp fused to perianth	No data	Yes	Yes	Yes	Yes

Micromorphological characters (Table 3)

Stomata morphology. Both *S. fruticosa* and *S. hispanica*, stomata are paracytic and they are well characterized by their deeply sunken guard cells compared to both epidermal and subsidiary cells. This stomatal morphology is named as sunken stoma (Fig. 2).

Pollen characteristics. Pollen is constantly pantoporate, apolar, with an equinulate surface characterised by simple pores (Fig. 3). This morphology was identical for *S. fruticosa* and *S. hispanica*.

Seeds. Concerning to seminal coat, the epidermic cells are flattened with a polygonal morphology. Two different kinds of trichomes were observed in both *S. fruticosa* and *S. hispanica* samples: (1) papillae and (2) short and conic hairs with a wide base (Fig. 4). These two morphologies can be easily observed in different individuals of the same population and also within the same seed.

Chromosome numbers (Table 3)

The two studied south-eastern Iberian Peninsula populations were hexaploid, $2n=54$ (Fig. 5).

DISCUSSION

Sarcocornia is a notable complex genus as has been reported by several authors (Shepherd & al., 2005, Alonso & Crespo, 2008; Steffen & al., 2010; Guilló & al., 2012), who also highlighted the importance of SEM characters such as seminal coat and stomata to identify among taxa. These morphological characters are rather stable as compared to other vegetative and reproductive features (e.g. habit, size of inflorescences), which might vary depending on the fluctuations of certain ecological conditions (e.g. water level, salinity, etc.).

The original description of *Sarcocornia hispanica* was mainly based on the life form (habit), shape of leaf apex, pericarp, seminal features (Fuente & al., 2011). Concerning to life form, many authors settled it as a taxonomic character to differentiate between *S. perennis* and *S. fruticosa*. The former is well characterised by rooting branches and a prostrate habit against an erect habit without rooting branches for *S. fruticosa* (Quézel & Santa, 1963; Pignatti, 1982; Bolòs & Vigo, 1990; Castroviejo, 1990; Coste, 2007; Jeanmonod & Gamisans, 2007; Sánchez-Gómez & Guerra, 2007; Mateo & Crespo, 2009). Conversely, *S. fruticosa* and *S. hispanica*

Table 3. Micromorphological characters for *S. hispanica* and *S. fruticosa*. For *S. hispanica*, data from their original diagnosis (Fuente & al., 2011), from the natural type population (Las Virtudes, Spain) and natural populations recognised as *S. hispanica* according to Fuente & al. (2011) are provided. For *S. fruticosa*, data from its type location (Camargue, France) and other Mediterranean populations are exposed

	S. hispanica			*S. fruticosa*	
Characters	**Original diagnosis**	**Population of Las Virtudes (L14)**	**Other populations (L11, 12, 16)**	**Population of Camargue (L2, L3, L4)**	**Other Mediterranean populations**
Seed size (mm)	0.9-1.1×0.7-0.8	0.84-0.93×0.67-0.77	0.93-1.37×0.69-0.85	0.73-0.95×0.52-0.67	0.63-1.50×0.52-1.02
Seed shape	Rounded	Ovate to orbiculate	Ovate to orbiculate	Ovate to orbiculate	Ovate to orbiculate
Seed colour	Brownish	Brown	Brown	Brown	Brown
Seed orientation	Vertical	Vertical	Vertical	Vertical	Vertical
Exotesta indumenta	Verrucate, with papillae	Papillae, conic and short hairs	Papillae, conic and short hairs	Papillae, conic and short hairs	Papillae, conic and short hairs
Stomata type	No data	Paracytic	Paracytic	Paracytic	Paracytic
Guard cells position	No data	Sunken	Sunken	Sunken	Sunken
Pollen	No data	Polipantoporate	Polipantoporate	Polipantoporate	Polipantoporate
Chromosome numbers	$2n=54$	$2n=54$[1]	$2n=54$[2] (L11 and L12) $2n=72$[1]	$2n=54$[3]	$2n=36$[4] $2n=54$[1] $2n=72$[1]

[1]Castroviejo & Coello (1980); [2]Own data; [3]Labadie (1976); [4]Castroviejo & Lago (1992).

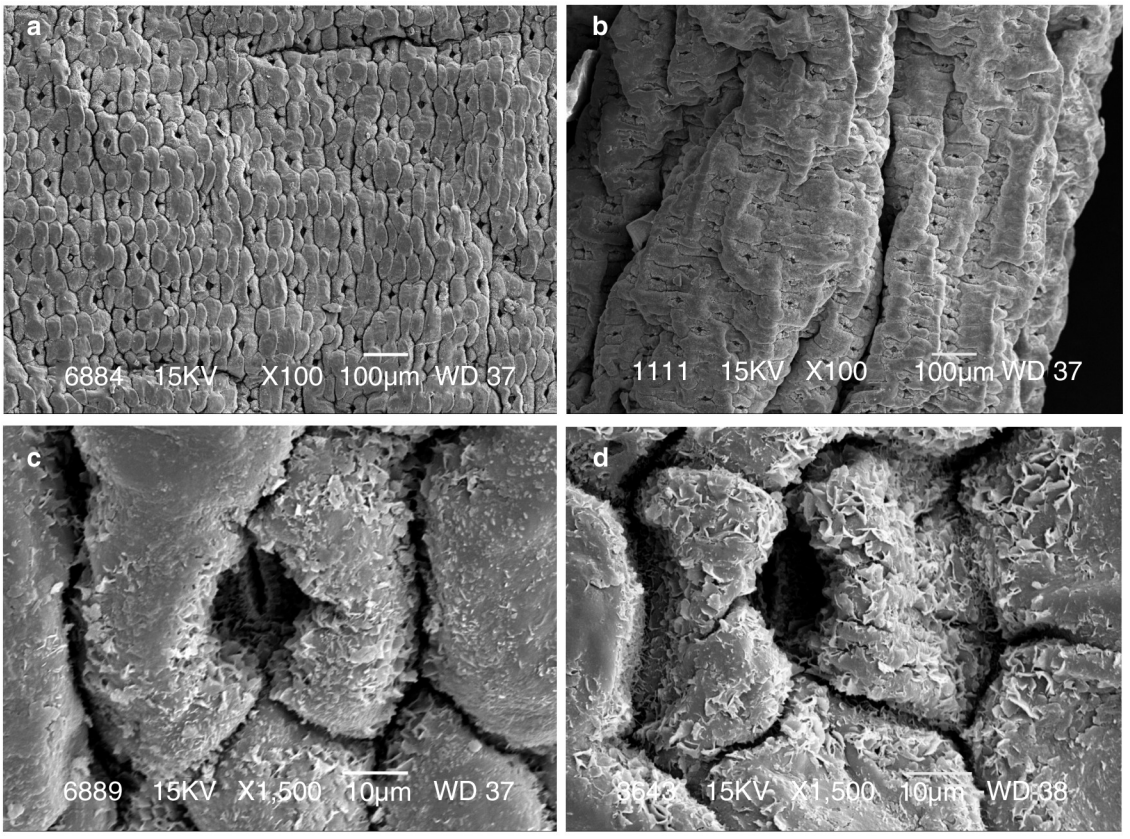

Fig. 2. Stomata. **a,** General aspect of the sunken stomata from the population of Saint Marie de la Mer, Camargue (France, ABH 52278); **b,** General aspect of the sunken stomata from the population of Las Virtudes, Villena (Spain, ABH 57792); **c,** Detailed aspect of a sunken stoma from the population of Saint Marie de la Mer, Camargue (France, ABH 52278); **d,** Detailed aspect of a sunken stoma from the population of Salinas de Braç del Port, Santa Pola (Spain, ABH 53139).

are both characterised by an erect life form and the lack of rooting branches as previous authors have pointed out (cf. Castroviejo, 1990; Fuente & al., 2011). Besides, the plant height reported for *S. hispanica* (up to 100-150 cm, Fuente & al., 2011) is rather overlapped to the obtained data for *S. fruticosa* (up to 180 cm) and also with the maximum value (up to 150 cm) stated by Castroviejo (1990). As a consequence, these vegetative features are not useful to differentiate between them.

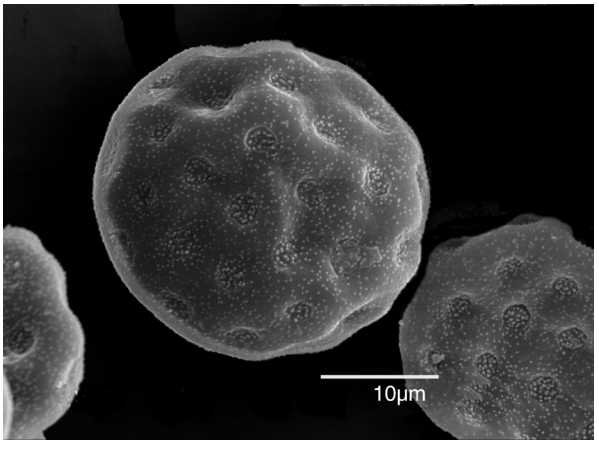

Fig. 3. SEM image of pollen of *S. fruticosa* (Tabernas, Almería-Spain; ABH 58415).

The apex of the segments was commonly used in the descriptions of some *Sarcocornia* species (Maire & Quézel, 1962; Castroviejo, 1990; Alonso & Crespo, 2008; Steffen & al., 2009, 2010). Fuente & al. (2011) pointed out the existence of a wide morphological range from a subacute to rounded apex for *S. hispanica* and Castroviejo (1990) reported a subacute morphology for *S. fruticosa*. Our data have showed a general tendency from obtuse to rounded apexes, which are noticeably included within the ranges reported by Fuente & al. (2011).

Fuente & al. (2011) used the presence of the pericarp partly fused to the seed as an own character of *S. hispanica* against the rest of the Iberian *Sarcocornia* species. On the basis of our data, all the studied populations also showed the pericarp relatively fused to seeds, and these are kept included in it though they are clearly visible because of the dehiscence of the utricule. Therefore, seeds are separated from the pericarp with difficulty, and pericarp residues are usually detectable in most of the seeds. These data are totally concordant with Shepherd & al. (2005).

Seed shape was also stated as one of the main characters to distinguish *S. hispanica* from other *Sarcocornia* taxa (Fuente & al., 2011). These authors reported the presence of rounded seeds, which falls within the variability here observed (from ovate to orbiculate). Additionally, seed size measured in the type locality of *S. hispanica* (Las Virtudes, Spain) was somehow lower than the original data done by Fuente & al. (2011), but these measures matched with

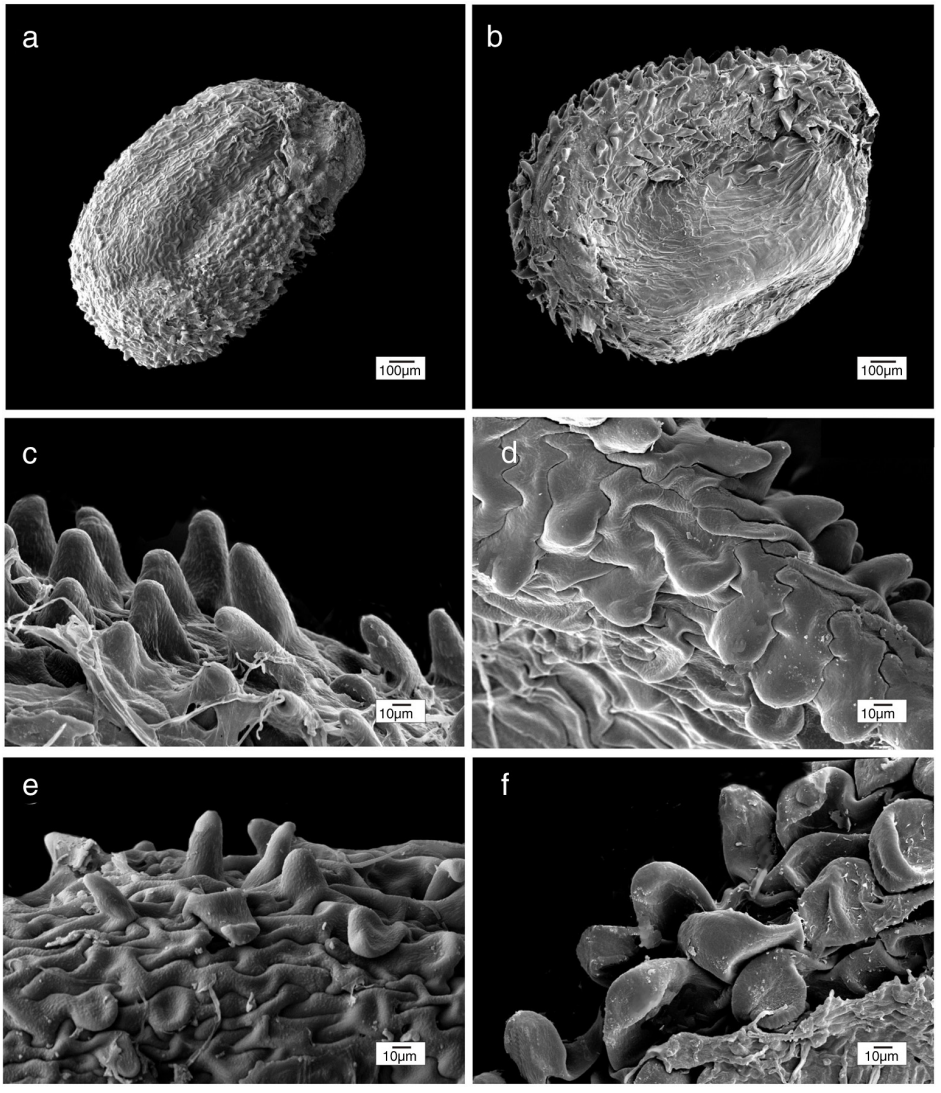

Fig. 4. Seeds. **a,** General aspect of a seed (Salinas de Bon Matí, Santa Pola-Spain; ABH 53143); **b,** General aspect of a seed (Saint Marie de la Mer, Camargue-France; ABH 52272); **c,** Aspect of conic and short hairs (Leucate, Camargue-France; ABH 52224); **d,** Papillae together with conic and short hairs (Leucate, Camargue-France; ABH 52224); **e,** Papillae together with conic and short hairs (Salinas de Braç del Port, Santa Pola-Spain; ABH 53147); **f,** Papillae (Las Virtudes, Villena-Spain; ABH 57792).

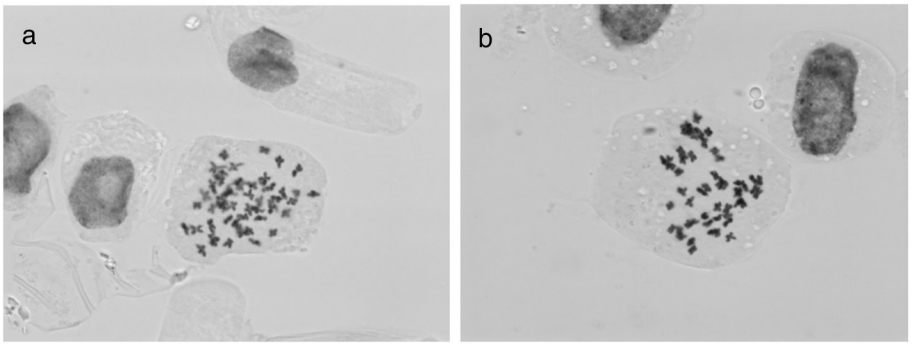

Fig. 5. Cells in metaphase displaying 54 chromosomes. **a,** Salinas del del Braç del Port (Alicante, Spain; ABH 53139); **b,** Laguna Salada de la Mata (Alicante, Spain; ABH 53093).

S. fruticosa data. As for previous morphological features, no tendency was newly observed between the studied species. Concerning to seed coat has been widely described for taxonomical purposes within the genus *Sarcocornia* (Shepherd & al., 2005; Alonso & Crespo, 2008; Steffen & al., 2009, 2010), and specially to distinguish between *S. fruticosa*

and *S. perennis* (Maire & Quézel, 1962; Meikle, 1977; Valdés & al., 1987b; Bolòs & Vigo, 1990; Castroviejo, 1990; Cabello 2011; Guilló & al., 2012). For *S. fruticosa*, the mentioned authors reported a seed ornamentation well characterised by the presence of short hairs, papillae or mamelons. Our data reveals the presence of this seminal ornamentation for all the studied seeds from the different Mediterranean populations, including those type localities from southeastern Iberian Peninsula and southern France populations. No tendency was observed among the studied populations. Fuente & al. (2011) reported a seminal morphology for *S. hispanica*, which is totally coincident with the morphology of the studied populations independently of the taxonomical designation and their geographical origin.

Additionally, other vegetative and reproductive features not mentioned by Fuente & al. (2011) have been analysed in detail to extend the morphological study between these two species. The segment size and shape were totally coincident among all the studied populations. The number of lateral spikes and their size were rather equivalent between the two type localities, and none difference was found among all the studied populations. Moreover, the wide spike reported by Fuente & al. (2011) is identical to our data from Camarga populations. Although some features related to the inflorescences have been previously used to identify among *Sarcocornia* taxa (e.g. Castroviejo, 1990), our results pointed out that these two features are not usefulness to discriminate between the two *Sarcocornia* species. Similarly, the pollen has shown the identical morphological features among all the studied populations, and hence it is similar among other *Sarcoconia* species and also among the genera of this family (Valdés & al., 1987a). As a result, pollen morphology should not be considered as a taxonomic character to support the identification among *Sarcocornia* species. Finally, fruit identification or any other related feature is not usually included in the *Sarcocornia* treatments (Maire & Quézel, 1962; Quézel & Santa, 1963; Valdés & al., 1987b; Bolòs & Vigo, 1990; Stace, 1991; Coste, 2007; Jeanmonod & Gamisans, 2007; Cabello, 2011), but certain contradictory descriptions have been given about its definition. Meikle (1977) reported the fruit of this genus as an utricule, whereas Castroviejo (1990) indicated it as an achene. Recently, Fuente & al. (2011) described the fruit of *Sarcocornia hispanica* as an achene, based on the pericarp appears partially fused to the seed. According to Font Quer (1989), the main differences between utricules and achenes are principally based on their dehiscence. This author defined an utricule as a dehiscent fruit against the permanent indehiscence of the achene. According to our observations, the fruit of *Sarcocornia* is always dehiscent, and consequently it should be considered as an utricule as Meikle (1977) initially reported.

Finally, Castroviejo & Coello (1980) and Castroviejo & Lago (1992) reported the hexaploid (2*n*=54), or even octoploid (2*n*=72) levels for *S. fruticosa* in many populations from the Iberian Peninsula, basically from southeastern territories (including the potential area of *S. hispanica*). Fuente & al. (2011) stated the presence of the hexaploid level for *S. hispanica* species, just based on the counts from the populations of Villena (type locality) and El Hondo, both in Alicante province. Likewise, our data have yielded the presence of the hexaploid level for Alicante populations, exactly from the populations Laguna Salada de La Mata (Torrevieja) and Salinas del Braç del Port (Santa Pola). Related to these two latter populations, Castroviejo & Coello (1980) also reported the highest level of ploidy (octoploid) for *Sarcocornia* samples of these areas, and they stated that no difference was found among individuals and localities characterised by different levels of ploidy. Moreover, the hexaploid level has been stated for *S. fruticosa* in other European territories as Portugal (Castro & Fontes, 1946) and France (Contandriopoulos, 1968; Labadie, 1976). Consequently, the level of ploidy within *Sarcocornia* would not provide any additional information to support the taxonomical differentiation between *S. fruticosa* and *S. hispanica*.

CONCLUSIONS

According to our data, no significant differences have been found between the widely distributed *S. fruticosa* and the recently described species *S. hispanica* on the basis of habit, branches, inflorescences, seeds and chromosome counts. The morphological comparison between individuals from the type populations of both *S. hispanica* (Las Virtudes, Spain) and *S. fruticosa* (Camargue, France) showed the lack of morphological differences between them. Besides, the morphological quantitative and qualitative charachters here obtained from the locality Las Virtudes (type locality of *S. hispanica*) and from other European populations fall within the variation reported by Fuente & al. (2011) for *S. hispanica*. Therefore, all this evidence together with the wide morphological plasticity observed in wild populations of the two taxa supports treating *S. hispanica* as a synonym of *S. fruticosa*, which was originally described by Linnaeus (1753).

Nomenclature and taxonomical treatment

Sarcocornia fruticosa (L.) A.J. Scott _in_ Bot. J. Linn. Soc. 75(4): 367. 1978

= *Salicornia europaea* L. var. *fruticosa* L., *Sp. Pl.*: 3 (1753) (Basion.)
= *Salicornia fruticosa* (L.) L., *Sp. Pl.* ed. 2: 5 (1762).
= *Arthrocnemum fruticosum* (L.) Moq., *Chenop. Monogr. Enum.*: 111 (1840)
= *Salicornia europaea* β *perennis* Gouan, *Hortus Monsp.*: 2 (1762)
= *Salicornia fruticosa* Willd., *Sp. Pl.* 1: 24 (1797)
= *Salicornia anceps* Lag., *Mem. Pl. Barrill.*: 52 (1817)
= *Salicornia fruticosa* α *glaucescens* Ten. *in* Syll. Pl. Fl. Neapol.: 582 (1831)
= *Salicornia fruticosa* β *deflexa* Rouy, *Fl. France* 12: 60 (1910)
= *Sarcocornia fruticosa* β *deflexa* C. Lahondère & Gamisans *in* Candollea 43(1): 368 (1988)
= *Sarcocornia hispanica* Fuente, Rufo & Sánchez-Mata *in* Lazaroa: 32 (2011)
= *Salicornia arabica* auct. non L. *Sp. Pl.* 1: 3 (1753)

Lectotypus: Designed by Ball (2007) in Jarvis (ed.) *Order out of Chaos*: 807 (2007): Herb. Burser XVI(2): 22 right specimen (UPS).

ACKNOWLEDGEMENTS

We are grateful to the curators and staff of the herbaria G, MA, MAF, VAL and W for their help with the studied material. The work was partly supported by the projects ACIE10-01 and ACIE11-05 (University of Alicante).

REFERENCES

Alonso, M.A. & De la Torre, A. 2002. Datos sobre las comunidades de *Sarcocornia fruticosa* (L.) A.J. Scott en la provincia Murciano-Almeriense (S.E. España). *Acta Botanica Malacitana* 27: 288-294.

Alonso, M.A. & Crespo, M.B. 2008. Taxonomic and nomenclatural notes on South American taxa of *Sarcocornia* (Chenopodiaceae). *Annales. Boanici Fennici* 45: 241-254. http://dx.doi.org/10.5735/085.045.0401

Álvarez Rogel, J. 1997. *Relaciones suelo-vegetación en saladares del Sureste de España*. 18-23, 31-43. Tesis Doctoral Univ. de Murcia, Murcia.

Ball, P.W. 1993. *Arthrocnemum* Moq. In: Tutin, T.G, Heywood, V.H., Burgess, N.A., Valentine, D.H., Walters, S.M. & Webb, D.A. (eds.), *Flora Europaea*, ed. 2, 1: 121. Cambridge Univ. Press. Cambridge.

Ball, P.W. 2007. *Sarcocornia fruticosa.* In: Jarvis, C. (ed.), *Order out of Chaos*: *Linnean Plant Names and their Types.* Published by the Linnean Society of London in association with the Natural History Museum, London.

Biondi, E., Blasi, C., Burrascano, S., Casavecchia, S., Copiz, R., Del Vico, E., Galdenzi, D., Gigante, D., Lasen, C., Spampinato, G., Venanzoni, R. & Zivkovic. L. 2010. *Italian interpretation Manual of the habitats (92/43/ EEC Directive)*. Ministry of Environment, Land and Sea Protection Nature Protection Directorat. Italy.

Bolòs, O. & Vigo J. 1990. *Flora dels Països Catalans*. Vol. 2. Editorial Barcino.

Cabello, J. 2011. *Sarcocornia* A.J. Scott. In: Blanca, G., Cabezudo, B., Cueto, M., Salazar, C. & Morales Torres, C. (eds.), *Flora Vascular de Andalucía Oriental*: 571. Universidades de Almería, Granada, Jaén y Málaga, Granada.

Castro, D. & Fontes F. C. 1946. Primeiro contacto citológico con a flora halófila dos Salgados de Sacavém. *Broteria* 15(1): 38-46.

Castroviejo, S. 1990. Chenopodiaceae. In: Castroviejo, S., Laínz, M., López González, G., Montserrat, P., Muñoz Garmedia, F., Pavia, J. & Villar, L. (eds.), *Flora Iberica* 2: 476-553. Real Jardín Botánico, CSIC, Madrid.

Castroviejo, S. & Coello P. 1980. Datos cariológicos y taxonómicos sobre las *Salicorniinae* A. A.J. Scott Ibéricas. *Anales del Jardín Botánico de Madrid* 37(1): 41-73.

Castroviejo, S. & Lago E. 1992. Datos acerca de la hibridación en el género *Sarcocornia* (Chenopodiaceae). *Anales del Jardín Botánico de Madrid* 50(2): 163-170.

Contandriopoulos, J. 1968. A Propos des nombres Chromosomiques des Salicornia de la región méditerranéenne. *Bulletin du Muséum d'Histoire Naturelle de Marseille* 28:45-52.

Costa, J.C., Arsénio, P., Monteiro-Henriques, T., Neto, C., Pereira, E., Almeida, T. & J. Izco 2009. Finding the Boundary between Eurosiberian and Mediterranean Salt Marshes. *Journal of Coastal Research* 56: 1340-1344.

Coste, H. 2007. *Flore descriptive et illustrée de la France de la Corse et des contrées limitrophes*: 189-191. Librairie scientifique et technique, Albert Blanchard 9, rue de Médicis, Paris 6°.

Day, P.D., Pellicer, J. & Kynast, R.G. 2012. Orange balsam (*Impatiens capensis* Meerb., Balsaminaceae): a re-evaluation by chromosome number and genome size. *Journal of the Torrey Botanical Society* 139(1): 26-33. http://dx.doi.org/10.3159/TORREY-D-11-00033.1

Figueroa, M.E., Castillo, J.M., Redondo, S., Luque, T., Castellanos, E.M., Nieva, F.J., Luque, C.J., Rubio-Casal, A.E. & Davy, A.J. 2003. Facilitated invasion by hybridization of *Sarcocornia* species in a salt-marsh succession. *Journal of Ecology.* 91: 616-626. http://dx.doi.org/10.1046/j.1365-2745.2003.00794.x

Font Quer, P. 1989. *Diccionario de botánica*. Barcelona, Lábor.

Freitag, H. 1989. Contribution to the Chenopod flora of Egypt. *Flora* 183: 149-173.

Fuente, V. de la, Rufo, L. & Sánchez-Mata, D. 2011. *Sarcocornia hispanica* (Chenopodiaceae), a new species from the Iberian Peninsula. *Lazaroa* 32: 9-13. http://dx.doi.org/10.5209/rev_LAZA.2011.v32.37817

Greuter, W., Burdet, H.M. & Long, G. 1986. *Med-Checklist vol.1.* Conservatoire et Jardin Botanique de Genève. Genève.

Guilló, A., Alonso, M.A., Juan, A. & Crespo, M.B. 2011. Nomenclatural notes on *Sarcocornia perennis* (Miller) A.J. Scott (Amaranthaceae). *Candollea* 66(2): 331-335. http://dx.doi.org/10.15553/c2011v662a9

Guilló, A., Alonso, M.A. & Juan, A. 2013. New insights of seminal and stomata morphology and their contribution to the taxonomy of the Old World *Sarcocornia* taxa and relatives. *Plant Systematics and Evolution*. 299(6):1185-1203. http://dx.doi.org/10.1007/s00606-013-0788-8

Jeanmonod, D. & Gamisans, J. 2007. *Flora Corsica:* 319-322. Édisud.

Kadereit, G., Mucina, L. & Freitag, H. 2006. Phylogeny of Salicornioideae (Chenopodiaceae): diversification, biogeography, and evolutionary trends in leaf and flower morphology. *Taxon* 55(3): 617-642. http://dx.doi.org/10.2307/25065639

Koce, J.D., Skondric, S., Bacic, T. & Dermastia, M. 2008. Amounts of nuclear DNA in marine halophytes. *Aquabotanic* 89: 385-389. http://dx.doi.org/10.1016/j.aquabot.2008.04.009

Kühn, U., Bittrich, R., Carolin, R., Freitag, H., Hedge, I.C., Uotila, P. & Wilson, P.G. 1993. Chenopodiaceae. Pages: 253-281 In: Kubitzki, W. (ed.), *Families and genera of vascular plants*. Vol. 2. Springer, Berlin. http://dx.doi.org/10.1007/978-3-662-02899-5_26

Labadie, J. P. 1976. In: A. Lóve. IOPB Chromosome number reports LIV. *Taxon* 25(5/6): 631-649.

Lagasca, M. 1817. *Memoria sobre las plantas barrilleras en España*. Imprenta Real, Madrid.

Lendínez, M.L., Marchal, F.M. & Salazar, C. 2011. Estudio florístico de los medios húmedos salinos de Andalucía (S. España). Catálogo y análisis de la flora vascular halófila. *Lagascalia* 31: 77-130.

Linnaeus, C. 1753. *Species Plantarum, II.* Londres.

López-González, G. 1997. Sobre las especies madrileñas de *Salicornia* L. (Incl. *Sarcocornia* A.J. Scott). *Anales del Jardín Botánico de Madrid* 55(2): 468-471.

Luque, T., Ruiz, C., Avalos, J., Calderón, I.L. & Figueroa, E. 1995. Detection and analysis of genetic variation in *Salicornieae* (Chenopodiaceae) using random amplified polymorphic DNA (RAPD) markers. *Taxon* 44: 53-63. http://dx.doi.org/10.2307/1222677

Maire, R. & Quézel, P. 1962. Chenopodiaceae. In: *Flore de L'Afrique du Nord*. Vol. 8. Éditions Paul Lechevalier 12, Rue de Tournon, 12, Paris.

Mateo, G. & Crespo, M.B. 2009. *Manual para la determinación de la flora valenciana*. Ed. Librería Compás, Alicante.

Meikle, R.D. 1977. *Flora of Cyprus*. Vol. 2. The Bentham-Moxon Trust. Royal Botanic Gardens, Kew.

Miller, P. 1768. *The gardener's and botanist's dictionary; containing the best and newest methods of cultivating and improving the kitchen, fruit, and flower garden, and nursery; of performing the practical parts of agriculture; of managing vineyards, and of propagating all sorts of timber trees*. F. & C. Rivington, London.

Molero, J. & Monserrat, J.M. 2006. Quenopodiáceas nuevas o raras para la flora de Marruecos. *Lagascalia* 26: 7-24.

Pignatti, S. 1982. *Flora d'Italia*. Volume primo. Edagricole, Edizione Agricole della Calderinis.r.l., Bologna.

Quézel, P. & Santa, S. 1963. Chenopodiaceae. In: Quézel, P. & Santa, S. (eds.), *Nouvelles Flore de L'Algérie et des Régions Désertiques Méridionales* (1963). Editions du Centre National de la Recherche Scientifique, Paris 7°.

Salazar, C., Torres, J.A., Marchal, F.M. & Cano, E. 2002. La vegetación edafohigrófila del distrito Guadiciano-Bastetano (Granada-Jaén, S. España). *Lazaroa* 23: 45-64.

Sánchez-Gómez, P. & Guerra J. (eds.). 2007. *Nueva Flora de Murcia. Plantas Vasculares*. DM, Librero Editor.

Shepherd, K.A. & Yan, G. 2003. Chromosome number and size variation in the Australian Salicornioideae (Chenopodiaceae)–evidence of polyploidisation. *Australian Journal of Botany* 51: 441-452. http://dx.doi.org/10.1071/BT03041

Shepherd, K.A., Macfarlane, T.D. & Colmer, T.D. 2005. Morphology, anatomy and histochemistry of Salicornioideae (Chenopodiaceae) fruits and seeds. *Annals of Botany* 95: 917-933. http://dx.doi.org/10.1093/aob/mci101

Stace, C. 1991. *New Flora of the British Isles*: 181-184. Cambridge University Press.

Steffen, S., Mucina, L. & Kadereit, G. 2009. Three new species of *Sarcocornia* (Chenopodiaceae) from South Africa. *Kew Bulletin* 64: 447-459. http://dx.doi.org/10.1007/s12225-009-9127-1

Steffen, S., Mucina, L. & Kadereit, G. 2010. Revision of *Sarcocornia* (Chenopodiaceae) in South Africa, Namibia and Mozambique. *Systematic Botany* 35(2): 390-408. http://dx.doi.org/10.1600/036364410791638379

Thiers, B. 2012. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium: http://sweetgum.nybg.org/ih/

Valdés, B., Díez, M.J. & Fernández, I. 1987a. *Atlas polínico de Andalucía Occidental*. Instituto de Desarrollo Regional de la Universidad de Sevilla y Excma. Diputación de Cádiz. Sevilla.

Valdés, B., Talavera, S. & Fernández-Galiano, E. 1987b. *Flora Vascular de Andalucía Occidental*. Vol. 1. Ketres Editora S.A. Barcelona.

Valdés, B., Rejdali, M., Kadmiri, A.A.E., Jury, S.L. & Montserrat, J.M. 2002. *Catalogue des plantes vasculaires du Nord du Maroc incluant des clés d'identification*. Consejo Superior de Investigaciones Científicas, Madrid.

Appendix 1. Table of localities and populations

CODE	COUNTRY	PROVINCE	MUNICIPALITY	LOCALITY	COORDINATES	ALTITUDE (m)	VOUCHER
L1	France	Var	Hyères	Les Salins, la Levée Saint-Nicolas des Vieux, salins d'Hyères	43° 6′ 40.0″N 6° 11′ 7.7″E	0	ABH 52214
L1	France	Var	Hyères	Carretera Capte-La Tour, Salins des Pesquiers, Les Salins d'Hyères	43° 7′ 13.5″N 6° 11′ 50.4″E	0	ABH 52209
L1	France	Var	Hyères	Salins des Pesquiers, Les Salins d'Hyères	43° 6′ 42.2″N 6° 12′ 36.1″E	0	ABH 52198
L2	France	Gard	Aigues Mortes	Carretera de Saintes-Maries-de-la-Mer	43° 34′ 48.4″N 4° 15′ 3.5″E	0	ABH 52252
L2	France	Bouches-du-Rhône	Arles	–	43° 40′ 52.6″N 4° 38′ 03.2″E	–	W 4489
L2	France	Bouches-du-Rhône	Saintes Maries de la Mer	Manade Raynaud, carretera a Aigues Mortes	43° 29′ 19.3″N 4° 22′ 21.9″E	0	ABH 52273
L2	France	Bouches-du-Rhône	Saintes Maries de la Mer	Cerca del Mas de Cacharel, 13460. Camarga Francesa	43° 28′ 11.7″N 4° 26′ 2.9″E	0	ABH 52283
L3	France	Aude	Leucate	Les Capitelles, cerca de Port Barcarès	42° 49′ 50.0″N 3° 1′ 28.1″E	0	ABH 52225
L4	France	Pyrénée-Orientales	Saint-Cyprien de Roselló	Canal de l'Aygual, saliendo del pueblo, D81A	42° 49′ 50.0″N 3° 1′ 28.1″E	0	ABH 52229
L5	Spain	Gerona	Torroella de Montgrí	Bassa Frare Ramón, L' Estartit	42° 1′ 43.9″N 3° 11′ 35.8″E	2	ABH 57797
L6	Spain	Tarragona	Amposta	Frente a la Isla de Buda, Delta del Ebro	40° 41′ 5.3″N 0° 50′ 46.5″E	0	ABH 54710
L7	Spain	Valencia	La Albufera	–	39° 21′N 0°19′ W	0	MA 158078
L8	Spain	Mallorca	Campos	Es Trenc, Es Cap de Sa Siquia	39° 10′ 2.2″N 2° 25′ 12.2″E	5	ABH 58418
L8	Spain	Mallorca	Colonia de Sant Jordi	Es Estanys	39° 19′ 2.6″N 2° 59′ 18.2″E	10	ABH 58309
L8	Spain	Mallorca	Archipiélago de Cabrera	Na Pobra	39° 11′ 28.5″N 2° 57′ 54.9″E	–	ABH 55057
L8	Spain	Mallorca	Archipiélago de Cabrera	Na Foradada	38° 43′ 46.0″N 1° 26′ 44.7″E	20	ABH 57428
L8	Spain	Mallorca	Archipiélago de Cabrera	Ses Rates	39° 7′ 41.3″N 2° 55′ 8.5″E	10	MA 143278
L9	Spain	Alicante	Calpe	Salinas El Saladar, junto a la explanada de la rotonda	38° 38′ 26.2″N 0° 3′ 31.4″E	0	ABH 53062
L10	Spain	Alicante	Elche	Agua Amarga	38° 15′ 49.9″N 0° 31′ 10.8″W	0	ABH 53127
L11	Spain	Alicante	Santa Pola	Lagunas de Bon Matí	38° 11′ 5.8″N 0° 37′ 30.3″W	3	ABH 53142
L11	Spain	Alicante	Santa Pola	Salinas del Bras del Port	38° 12′ 7.2″N 0° 34′ 43.9″W	8	ABH 53145
L12	Spain	Alicante	Torrevieja	Torrelamata, Laguna Salada de la Mata, Lo Blanco	38° 2′ 30.4″N 0° 40′ 31.1″W	10	ABH 53093
L13	Spain	Murcia	San Pedro del Pinatar	Salinas de San Pedro del Pinatar	37° 50′ 11.0″N 0° 46′ 21.6″W	0	ABH 53065
L14	Spain	Almería	Níjar	La Almadraba de Moteleva	36° 44′ 45.9″N 2° 12′ 16.8″W	15	ABH 53121

Appendix 1. *(continued)*

CODE	COUNTRY	PROVINCE	MUNICIPALITY	LOCALITY	COORDINATES	ALTITUDE (m)	VOUCHER
L14	Spain	Almería	Tabernas	Ayo. Cercano al Mini-Holliwood	37° 3′ 13.7″N 2° 24′ 54.6″W	–	ABH 58415
L15	Spain	Alicante	Villena	Las Virtudes	38° 39′ 1.8″N 0° 56′ 34.8″W	500	ABH 57792
L16	Spain	Granada	Cúllar (Baza)	Salado del Margen	37° 38′ 38.5″N 2° 35′ 10.5″W	843	MA 346484
L17	Spain	Albacete	Agramón	Microrreserva al lado del río Tobarra	38° 24′ 30.0″N 1° 38′ 13.4″W	400	ABH 53783
L17	Spain	Albacete	Cordovilla	Al lado de la valla "Los Altos / Casa Carcelen"	38° 33′ 8.9″N 1° 38′ 3.6″W	542	ABH 53736
L18	Spain	Cádiz	Chiclana de la Frontera	Playa de Sancti Petri, junto al poblado de Sancti Petri.	36° 23′ 30.0″N 6° 12′ 45.5″W	0	ABH 53274
L18	Spain	Cádiz	Sanlúcar de Barrameda	Bonanza, Salinas de Bonanza	36° 49′ 5.5″N 6° 20′ 34.6″W	2	ABH 53305
L29	Spain	Vizcaya	Gernika	Murueta	43° 21′ 8.7″N 2° 40′ 45.0″W	2	ABH 40402
L20	Spain	Cantabria	Marina de Cudeyo	Marisma	43° 25′ 53.1″N 3° 45′ 13.3″W	3	ABH 54704
L20	Spain	Cantabria	Santander	Astillero, Marismas Negras	43° 24′ 13.7″N 3° 50′ 23.2″W	5	ABH 54708
L21	Spain	Asturias	Villaviciosa	Margen occidental Ría de Villaviciosa	43° 30′ 26.0″N 5° 25′ 28.8″W	3	ABH 54698
L22	Portugal	Baixo Alentejo	Carrasqueira	–	–	10	ABH 41436
L23	Portugal	Algarve	Almansil	Parque Natural de Ria Formosa, praia de Ançao	37° 2′ 0.1″N 8° 2′ 39.4″W	20	ABH 48035
L23	Portugal	Algarve	Faro	Ludo	37° 1′ 26.3″N 7° 59′ 58.0″W	–	ABH 58300
L23	Portugal	Algarve	Faro	Faro, Praia Faro	37° 2′ 57.10″N 7° 45′ 17.6″W	–	ABH 59318
L24	Portugal	Algarve	Faro	Aljezur, Praia Amoreina	37° 20′ 40.4″ N 8° 50′ 13.3″W	–	ABH 59331
L25	Morocco	Tanger-Tétouan	Larache	–	35°N 6°W	0	ABH 51020
L26	Morocco	Oriental	Alhoceima	Bahía de Alhoceima	35° 11′ 46.4″N 3° 48′ 14.7″W	14	ABH 58416
L27	Morocco	Oriental	Nador	Arekmane	34° 54′ 33.1″N 2° 45′ 33.0″W	1	ABH 58327
L28	Algeria	Orán	La Macta	La Macta, Saladar	35° 47′ 8.6″N 0° 7′ 24.1″W	–	ABH 59341
L29	Algeria	M'Sila	Chellal	Chott El Hodna	35° 30′ 46.8″N 4° 31′ 18.5″E	450	ABH 59960

Anales del Jardín Botánico de Madrid 71(2): e011 2014. ISSN: 0211-1322. doi: http://dx.doi.org/10.3989/ajbm.2338

Appendix 2

Additional studied material

Sarcocornia fruticosa (L.) A.J. Scott
ALGERIA, **Oran**: La Macta, 30SYE6064, 3 m, 13–VI–2010, *A. Juan, M. Martínez-Ortega, S. Barrios & J. Peñas* (ABH 59340).

SPAIN, **Alicante**: Agua Amarga, saladar, 30SYH1641, 0 m, 7–IX–1996, *E. Camuñas* (ABH 30671). Alicante, Bco. de Agua Amarga, 30SYH1644, 40 m, 13–X–1996, *E. Camuñas*, (ABH 32374). Alicante, Agua Amarga, 30SYH1641, 0 m, 9–XI–1996, *E. Camuñas & M.B. Crespo* (ABH 32383). Alicante, Bahía de los Pinos, 30SYH2448, 2 m, 7–IX–1997, *E. Camuñas & M.B. Crespo* (ABH 38264). Elche, Saladar de Agua Amarga, 30SYH1540, 1 m, 19–IV–2008, *M.A. Alonso & J. Izco* (ABH 52195) Elche, Saladar de Agua Amarga, 30SYH1738, 8 m, 30–X–2007, *A. Guilló, J.C. Agulló, P. Rico, J.L. Villar & A. Vicente* (ABH 53128, ABH 53129, ABH 53130, ABH 53131, ABH 53132, ABH 53133, ABH 53134, ABH 53135, ABH 53136, ABH 53137, ABH 53138). Santa Pola, Playa Lisa, 30SYH1230, 22–IX–2009, (ut *Sarcocornia hispanica* Fuente, Rufo & Sánchez-Mata), *V. de la Fuente*, (MAF 169311). Santa Pola, Playa Lisa, 30SYH1230, 29–VIII–2008, (ut *Sarcocornia hispanica* Fuente, Rufo & Sánchez-Mata), *V. de la Fuente*, (MAF 169312). Santa Pola, Salinas Bon Matí, 30SYH0829, 8 m, 30–X–2007, *A. Guilló, J.C. Agulló, P. Rico, J.L. Villar & A. Vicente* (ABH 53139, ABH 53140, ABH 53141, ABH 53143, ABH 53144). Santa Pola, Salinas del Braç del Port, 30SYH1231, 8m, 30–X–2007, *A. Guilló, J.C. Agulló, P. Rico, J.L. Villar & A. Vicente* (ABH 53146, ABH 53147, ABH 53148). Torrevieja, Laguna Grande, 30SYH0308, 22–IX–2009, (ut *Sarcocornia hispanica* Fuente, Rufo & Sánchez-Mata), *V. de la Fuente, L. Rufo & N. Rodríguez* (MAF 169310). Villena, Las Virtudes, 30SXH8176, 29–VIII–2008, (ut *Sarcocornia hispanica* Fuente, Rufo & Sánchez-Mata), *V. de la Fuente* (MAF 169314). Villena, Salero Viejo, 30SXH8080, 500 m, 24–XI–1991, *M. A. Alonso*, (ABH 8312). **Albacete**: Agramón, microrreserva al lado del río Tobarra, 30SXH2053, 531 m, 13–II–2009, *A. Guilló, N. Jover & A. Andric* (ABH 53769). Agramón, microrreserva al lado del río Tobarra, 30SXH2053, 531 m, 13–II–2009, *A. Guilló, N. Jover & A. Andric* (ABH 53770, ABH 53771, ABH 53772, ABH 53773, ABH 53774, ABH 53775, ABH 53776, ABH 53777, ABH 53778, ABH 53780). Cordovilla, al lado de la valla "Los Altos / Casa Carcelen", 30SXH1968, 542m, 13–II–2009, *A. Guilló, N. Jover & A. Andric* (ABH 53749, ABH 53750, ABH 53751, ABH 53752, ABH 53753, ABH 53754, ABH 53755, ABH 53756, ABH 53757). Cordovilla, 30SXH1968, 531 m, 13–II–2009, *A. Guilló, N. Jover & A. Andric* (ABH 53761, ABH 53762, ABH 53763, ABH 53764, ABH 53765, ABH 53766, ABH 53767, ABH 53768). Cordovilla, 7–I–1987, *Peris & Stübing* (VAL 14649). **Almería**: Níjar, La Almadraba de Moteleva, Punta SE de salinas, orilla norte, 30SWF7167, 15 m, 5–IV–2008, *B. Amat & J.C. Agulló* (ABH 53122, ABH 53123). Roquetas y Cabo de Gata, (ut *Salicornia anceps* Lag.) S. Rojas Clemente (MA 29474) **Asturias**: Villaviciosa, margen occidental Ría de Villaviciosa, Olivar, Playa Misiego, 30TUP0420, 3 m, 17–VII–2009, *A. Guilló & M. Plaza* (ABH 54696, ABH 54697, ABH 54699, ABH 54700). **Cádiz**: Sanlúcar de Barrameda, Bonanza, carretera de Bonanza, antes de la explotación salinera, al lado del puerto, detrás de la fábrica Frusana, 29SQA3776, 2 m, 07–X–2008, *A. Guilló & M. Plaza* (ABH 53310, ABH 53311, ABH 53312, ABH 53313, ABH 53315). Chiclana de la Frontera, Playa de Sancti Petri, junto al poblado de Sancti Petri y enfrente del Caño Chamarro, primera curva de la carretera antes de llegar al puerto, al lado izquierdo del paseo, 29SQA5031, 0 m, 6–X–2008, *A. Guilló & M. Plaza* (ABH 53281, ABH 53275, ABH 53276). Chiclana de la Frontera, Sancti Petri, Salinas de los Carboneros. Frente a la calle Santa María de las Mogarizas (P.N. de la Bahía de Cádiz), hacia la derecha del camino, 29SQA5331, 6 m, 06–X–2008, *A. Guilló & M. Plaza* (ABH 53290). Chiclana de la Frontera, Playa de Sancti Petri, junto al poblado de Sancti Petri y enfrente del Caño Chamarro, en la recta de la carretera que va al puerto, al lado izquierdo del paseo,29SQA5031, 0 m, 06–X–2008, *A. Guilló & M. Plaza* (ABH 53272, ABH 53273, ABH 53272, ABH 53273). **Gerona**: Torroella de Montgrí, Bassa Frare Ramón, L'Estartit, 31TEG1653, 2 m, 17–IX–2010, *A. Juan, M.A. Alonso & S. Saura* (ABH 57799). **Granada**: El Margen, Cullar Baza, communatés des *Arthrocnemetalia,* 850 m, 9–X–1981, *J.M. Losa Quintana* n° 10127 (MA 377603, MA 298345, G 277621). Cullar Baza, 850 m, 9–X–1981, *Losa Quintana* (VAL 13104). Cullar Baza, 22–VI–1988, *B. Valdés, S. Talavera, G. Aziar, D. Jeanmonod, N. Galland, U. Matthäs, V. Stevanovic, P. Minissale, S. Fici, B. Foggi, M. Watson, P. Hinz & J.M. Romero* N° Rec. It1548/88 (G 412856). **Islas Baleares**: Archipiélago de Cabrera, Isla Na Pobla, rocas marítimas, 21–V–1949, (*ut Salicornia fruticosa* L.), *F. Palau* (MA 143281). Archipiélago de Cabrera, Isla Na Horadada, rocas marítimas, 21–V–1949, (*ut Salicornia fruticosa*), *F. Palau* (MA 143280). Mallorca, Campos, Es Trenc, Es Cap de Sa Siquia, 31SDD9955, 5 m, 12–XI–2008, *A. Guilló & J.C. Agulló* (ABH 58307, ABH 58308). Mallorca, Campos, Platja de Ses Trenc, Saladar de Campos, 31SDD9954, 1 m, 28–X–2008, *A. Guilló, A. Juan & J.C. Agulló* (ABH 58316, ABH 58317, ABH 58318, ABH 58319, ABH 58320). Mallorca, Campos, Es Trenc, Es Cap de Sa Siquia, 31SDD499355, 5 m, 12–XI–2008, *A. Guilló & J.C. Agulló* (ABH 58419, ABH 58420, ABH 58421, ABH 58422, ABH 58423, ABH 58424, ABH 58425). *A. Guilló & J.C. Agulló* (ABH 58429, ABH 58430, ABH 58431, ABH 58432). Mallorca, Colonia de Sant Jordi, Es Estanys, 31SDD9952, 1 m, 12–XI–2008, *A. Guilló & J.C. Agulló* (ABH 58311). **Murcia**: San Pedro del Pinatar, Salinas de San Pedro del Pinatar, cerca del aparcamiento de playa de "La Torre Derribada" (punto de información), 30SXG9888, 0 m, 16–V–2008, *A. Guilló & M. Plaza* (ABH 52186, ABH 52187, ABH52188, ABH 52189, ABH 52190). San Pedro del Pinatar, Salinas de San Pedro del Pinatar, al lado de la torre con paneles de información explicativos, 30SXG9791, 0 m, 16–V–2008, *A. Guilló & M. Plaza* (ABH 52191, ABH 52192, ABH 52193, ABH 52194). San Pedro del Pinatar, Salinas de San Pedro del Pinatar, principio de la salina, al lado de la carretera, 30SXG9690, 0 m, 16–V–2008, *A. Guilló & M. Plaza* (ABH 53066, ABH 53067, ABH 53068, ABH 53069, ABH 53071, ABH 53072, ABH 53073). San Pedro del Pinatar, Salinas de San Pedro del Pinatar, saladares secos por detrás de la torre, 30SXG9791, 0 m, 16–V–2008, *A. Guilló & M. Plaza* (ABH 53074, ABH 53075, ABH 53076, ABH 53077, ABH 53078, ABH 53079). **Valencia**: La Albufera, 22–V–1958, (*ut Salicornia fruticosa* L.), *Borja* (MA 200841. Valencia, (*ut Salicornia fruticosa* L.) *Cavanilles* (MA 29440).
FRANCE. **Aude**: Leucate, Les Capitelles, cerca de Port Barcarès, 31TEH0242, 0 m, 2–IV–2008, *A. Guilló, A. Juan & J.C. Agulló* (ABH 52227, ABH 52228, ABH 52230, ABH 52231, ABH 52232, ABH 52233). **Bouches-du-Rhône**: Saintes-Maries-de-la-Mer, Manade Raynaud, carretera a Aigues-Mortes, 31TFJ1116, 0 m, 2–IV–2008, *A. Guilló, A. Juan & J.C. Agulló* (ABH 52268, ABH 52269, ABH 52270). Saintes-Maries-de-la-Mer, cerca del Mas de Cacharel, 13460, 31TFJ1614, 0 m, 2–IV–2008, *A. Guilló, A. Juan & J.C. Agulló* (ABH 52280, ABH 52281, ABH 52284). Saintes-Maries-de-la-Mer, Manade Raynaud, carretera de a Aigues Mortes, 31TFJ1116, 0 m, 2–IV–2008, *A. Guilló, A. Juan & J.C. Agulló* (ABH 52272). **Gard**: Aigues-Mortes, carretera de Saintes-Maries-de-la-Mer, pasado cruce Aigues-Mortes y Mont Calm, a 12 km de Aigues-Mortes, al lado de una casa de venta de productos, 31TFJ0126, 0 m, 2–IV–2008, *A. Guilló, A. Juan & J.C. Agulló* (ABH 52257, ABH 52259). Aigues-Mortes, saladar fuera de la muralla. Camarga Francesa, 31TEJ9624, 0 m, 02–IV–2008, *A. Guilló, A. Juan & J.C. Agulló* (ABH 52263). **Pyrénée-Orientales**: Saint-Cyprien de Roselló, Canal de l'Aygual, saliendo del pueblo, D81A, 31TEH0217, 0 m, 3–IV–2008, *A.Guilló, A. Juan & J.C. Agulló* (ABH 52244, ABH 52245, ABH 52246, ABH 52247). **Var**: Hyères, Salins des Pesquiers, Les Salins d'Hyères, 32TKN7377, 0 m, 1–IV–2008, *A. Guilló, A. Juan & J.C. Agulló* (ABH 52196, ABH 52197, ABH 52199, ABH 52200, ABH 52201, ABH 52202, ABH 52203, ABH 52204). Hyères, Les Salins d'Hyères, Salins des Pesquiers, carretera Capte-La Tour, frente hotel Ibis, 32TKN7278, 0 m, 1–IV–2008, *A. Guilló, A. Juan & J.C. Agulló* (ABH 52210, ABH 52211, ABH 52212).
MOROCCO. **Al Hoceima**: Bahía de Al Hoceima, 30SVD268951, 14 m, 23–IV–2009, *M.B. Crespo, A. Guilló, L. Sáez, M.A. Alonso, A. Juan* & al. (ABH 58331). Bahía de Al Hoceima, 30SVD240946, 9 m, 23–IV–2009, *M.B. Crespo, A. Guilló, L. Sáez, M.A. Alonso, A. Juan* & al. (ABH 58417). Bahía de Alhucemas, en dunas secundarias húmedas, FC 5235, 27–V–1981, *S. Castroviejo, J. Fdez. Casas, F. Muñoz Garmendía & A. Susana* (MA 477654). **Región Oriental**: Nador, Arekmane, 30SWD198890, 1 m, 19–IV–2008, *M.B. Crespo, A. Guilló, L. Sáez, M.A. Alonso, A. Juan & al.* (ABH 58321, ABH 58324, ABH 58326, ABH 58328, ABH 58329, ABH 58405, ABH 58406, ABH 58409). **Tánger-Tetuán**: Cerca de Larache, saladar, 3m, 7–XII–1999, (*ut Salicornia longispicata* A. Chev.) *M.A. Alonso* (ABH 45450).
PORTUGAL. **Algarve**: Faro, Praia de Faro, 29SPB107010, 3 m, 23–III–2008, *A. Juan & P. Vila* (ABH 59319, ABH 59320, ABH 59321, ABH 59322, ABH 59323). Faro, Aljezur, Praia de Amoreira, 29SNB144331, 3 m, 23–III–2008, *A. Juan & P. Vila* (ABH 59332, ABH 59334).

Associate Editor: Javier Fuertes
Received: 25-XI-2013
Accepted: 01-IX-2014