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PHYTOSOCIOLOGICAL REVIEW OF PSAMMOPHILOUS VEGETATION OF THE CANARY ISLANDS

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Abstract – To date, over 25 syntaxa have been described for the Canarian vegetation to integrate plant communities related to the presence of sand on the substrate to a greater or lesser degree. These plant communities have been located in different phytosociological classes, depending on the analyses by different authors. In this paper, a review of all these plant communities is conducted primarily by analysing the appropriateness of using certain species as characteristic of this type of vegetation. Finally, a syntaxonomical catalogue is presented in which both plant communities described so far are integrated and which seems to be valid to explain this type of vegetation on the Canary Islands, as others plant communities have been described as novelties and integrate ecotone situations between different types of vegetation and psammophilous plant communities. The *Launaeo arborescentis-Schizogynetum glaberrimae* association, which integrates arid nitrophilous scrubland of south Gran Canaria is described. For the *Launaeo arborescentis-Schizogynetum glaberrimae* association and for associations *Plocametum pendulae* and *Atriplici ifniensis-Tamaricetum canariensis*, psammophilous subassociations are defined by the presence of psammophytic species.

Keywords: Dune vegetation, Canary Islands, Macaronesia, phytosociology, psammophytic vegetation

Introduction

The presence of sand on the soil where vegetation develops determines, to a large extent, its characteristics; the adaptation of such vegetation to these conditions becomes the main environmental factor influencing the distribution of plant species in aeolian sedimentary systems. Thus, regardless of the climate (with some variations depending on rainfall and wind, which determine the vegetation development; see Doing, 1985), coastal dune systems have common environmental characteristics that determine the existence of psammophilous species and plant communities adapted to high levels of environmental stress (Hesp & Martinez, 2007). Within coastal dune fields, there are a number of environmental factors that influence zonation and succession processes of psammophilous vegetation, such

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as burial by sand (Moreno-Casasola, 1986; Hesp, 1991; Maun, 2008), salt spray (Oosting & Billings, 1942; Wilson & Sykes, 1999), topography, exposure to wind and waves, chemical characteristics of the substrate, salinity of the substrate, aeolian sedimentary activity, type of landforms, rate of movement of the dunes, and depth and salinity of groundwater (Ranwell, 1959; Willis et al., 1959a, 1959b; Hernández-Cordero et al., 2006; Lane et al., 2008; Miot da Silva et al., 2008; Honrado et al., 2009; Fenu et al., 2013; Hernández-Cordero et al., 2015a; Hernández-Cordero et al., 2015b). However, this variety of environmental conditions also permits the existence of species and plant communities that are not strictly psammophytic. Such is the case of dune slacks, where an upwelling of the underlying substrate occurs or the depth of the water table decreases, allowing the development of hygrophilous or halophilous species and plant communities, among others.

From the phytosociological point of view, this diversity has led to the description of a significant number of syntaxa to integrate this type of vegetation, such as graminoid or chamaephyte vegetation (*Euphorbio paraliae-Ammophiletea australis*; *Honckenyo-Elymetea arenarii*; *Ambrosietea chamissonis*; *Atriplici-Frankenietea palmeri*; *Euphorbio leucophyllae-Sporoboletea virginici*), nitrophilous therophytes (*Cakiletea maritimae*; *Euphorbio leucophyllae-Sporoboletea virginici*), eutrophilous therophytes (*Malcolmietalia*), etc. (Eskuche, 1992; Rivas-Martínez et al., 2001; Peinado et al., 2011).

The aim of this paper is to analyse Canarian psammophilous vegetation, both by reviewing the aforementioned syntaxa as well as by describing several new plant communities that advance the field's understanding of ecotonic relations established between the psammophilous vegetation and other plant communities. To these ends, it is essential to analyse two important issues: to differentiate psammophilous habitats from others where sand is shallow and to identify the characteristic ecological and syntaxonomical species of these psammophilous plant communities.

Study area

All plant communities analysed in this paper were in Canarian province of the Canary-Madeirense subregion of the Mediterranean biogeographical region (Rivas-Martínez, 2007). This Province includes the Canary Islands and Selvagens Islands.

The Canary Islands are located in the Atlantic Ocean near the coast of northwest Africa. Due to their unique ecological characteristics, the Canary Islands have traditionally been integrated into the much-discussed Macaronesian biogeographical region (Salas-Pascual & Naranjo-Cigala, 2016). This study focuses on the vegetation associated with aeolian sedimentary systems in the Selvagens Islands and the Canary Islands.

The Canary Islands have a subtropical climate with mediterranean characteristics. The annual average temperature and annual average rainfall have altitudinal variations ranging between 18-22°C and less than 250 mm on the coast (arid climate), between 11-18ºC and 300-1300 mm in mid-altitude areas, and between 3.5-11ºC and 500-600 mm at the summit (Fernández-Palacios and De Nicolás, 1995; Del Arco et al., 2010). The zonal vegetation is associated with different climatic zones with variations between islands and from sea to summit, consisting of the following types (Del Arco et al., 2010): the coastal zone, where vegetation consists by xerophytic scrubs with different associations dominated mainly by *Euphorbia balsamifera* and *Euphorbia canariensis* (class *Kleinio-Euphorbietea canariensis*); thermophile forests, with *Olea cerasiformis*, *Pistacia lentiscus*, *Pistacia atlantica* and *Juniperus turbinata* subsp. *canariensis* (class *Rhamno crenulatae-Oleetea cerasiformis*) as the main tree species; on windward areas and under the influence of the mists generated by the trade winds when they collide with the insular relief, laurel forests (class *Pruno-Lauretea novocanariensis*) are located; above the influence of the mists *Pinus canariensis* forests (class *Chamaecytiso-Pinetea canariensis*) are located; and at higher altitudes high mountain scrubs extend, being dominated by *Spartocytisus supranubius* and *Viola cheiranthifolia* (*Spartocytisetum supranubii* and *Violetum cheiranthifolii*).

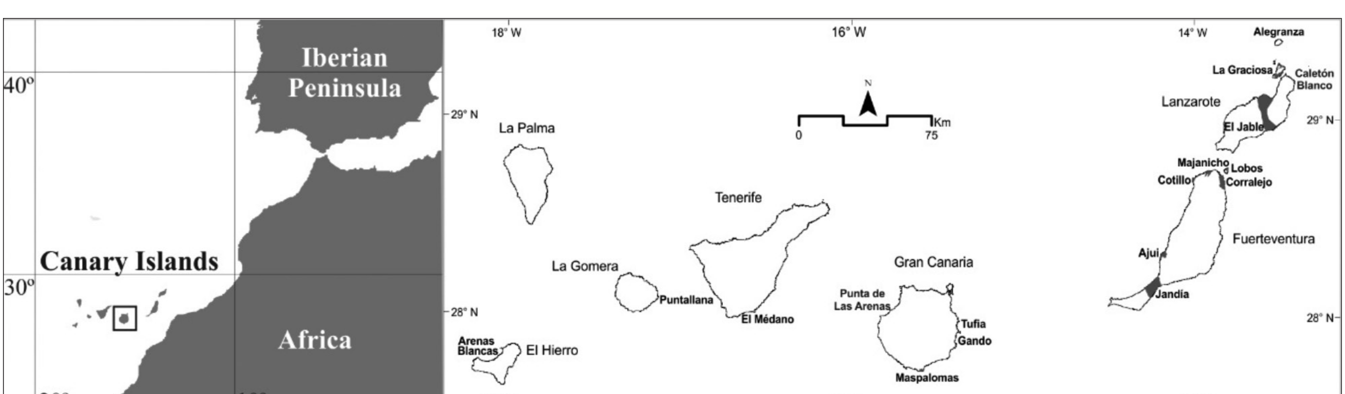

Figure 1. Location of the Canary Islands and the main aeolian sedimentary systems (modified from Hernández-Calvento et al., 2009).

Azonal plant communities associated with specific soil conditions also appear. This is the case of psammophilous vegetation, which is located on the sand plains and coastal dune fields (Figure 1).

Aeolian sedimentary systems are scarce in the Canary Islands, where rocky shores predominate. The sources of the sediments that form the aeolian sedimentary systems in the Canary Islands are mainly of marine origin, so the sands have a high proportion of organogenic components. Terrigenous components are also present, formed by fragments of volcanic materials provided by ravines and the erosion of sea cliffs. The dune systems of the Canary Islands are located in areas with an arid climate, which, together with the presence of intense and constant winds (NE trade winds), favours the mobility of sediments. For this reason, they are or have been in the recent past transgressive systems, such that the sands move across the interior of the islands as free dunes (transversal and barchanoid ridges, barchan dunes, and sand sheets) from hundreds of metres to several kilometres away from the sediment input areas. Additionally, the dunes have high rates of advance (Jiménez et al., 2006; Hernández-Cordero et al., 2015b). These environmental characteristics hinder the colonization of vegetation, which is mainly composed of plant communities and species shared with the northwest coast of Africa (from southern Morocco to Mauritania) and Macaronesia, with some of the species endemic to the Canary Islands (Santos, 1993; Géhu & Biondi, 1998). The nanophanerophyte *Traganum moquinii* is remarkable among these plant species, insofar as it generates a foredune with hummock morphology (Hernández-Cordero et al., 2015c). This differs with respect to European temperate zones, where the foredune normally consists of a continuous dune ridge because of greater vegetation cover and also because the plant species that form the foredune are herbaceous plants equipped with rhizomes. All of these characteristics demonstrate that Canarian dune systems present singularities with respect to those throughout the rest of Europe (Hernández-Cordero et al., 2015c).

Background

The phytosociological study of the psammophilous vegetation in the Canary Islands has occurred over the last 50 years, jointly with the beginning of works dedicated to the plant communities of this archipelago. Such characterization has been affected by the difficulty of defining which species are characteristic of this type of vegetation in the Canaries, as many of the species that grow in sandy environments also grow in other types of habitats, such as salt marshes or coastal cliffs. Hence, the associations described have been integrated in various upper syntaxa that have varied from one study to another. Before starting this section dedicated to the successive description of the psammophilous plant communities of the Canary Islands, it should be noted that because most of these syntaxa have experienced nomenclatural changes related to the changes in the species' names used to form the association name, we have preferred to use the latest corrected forms according to Rivas-Martínez et al. (2011).

The plant communities described so far are included in Table 1, which presents both associations validly published and those plant communities that were defined as such without being validly nominated as phytosociological associations. We have respected the names of associations and superior syntaxa proposed by other authors, except nomenclatural changes resulting from taxonomic changes of species that form the binomen. This table shows the different proposals proposed by each of the authors, either in publications wherein new plant communities of this type of vegetation are described or in papers devoted to the review of Canarian vegetation. The different syntaxa among the main types of psammophilous vegetation are described in the table, differentiating among perennial psammophilous plant communities, halo-psammophilous plant communities, halophilous plant communities that may have a surface layer of sand (Table 1a), therophyte psammophilous vegetation (Table 1b), ecotonic vegetation between psammophilous plant communities and other type of vegetation (Table 1c), and nitro-psammophilous vegetation (Table 1c).

The changes that many plant communities have experienced-i.e., changing from one syntaxon to another-have also led to great confusion among the species that characterize this type of vegetation in the Canaries. Thus, species such as *Polycarpaea nivea*, *Tetraena fontanesii* and *Ononis hesperia* have been considered in the literature to be indistinctly characteristic of *Euphorbio-Ammophiletea*, *Pegano-Salsoletea*, or *Polycarpaeo-Traganetea*.

Methods

To achieve the objectives defined above, we studied the degree of similarity between different relevés used in the descriptions of each community as presented in Table 1. To that end, we constructed a database including all relevés in the original tables published by the authors of the studied syntax as well as new relevés conducted by the authors of the present paper.

The newer relevés were prepared for three thus-far unidentified psammophile subassociations. To validate one of these subassociations, it was necessary to prepare relevés to determine an association. The relevés were prepared during the years 2001, 2005, and 2016. Plots of 100 m^2 to 200 m^2, were selected among central zones of vegetation units with homogeneous floristic composition. The reason for these

Table 1. Historical scheme of the study of Canarian psammophilous vegetation. In bold are associations described by the aforementioned authors.

Table 1a

Author	Psammophilous scrub	Halo-psammophilous scrub		Halo-nitrophilous scrub
Esteve 1968	*Ammpophiletea (“canariensis”); Zygophyllion fontanesii;* ***Polycarpaeo-Lotetum lancerottensis***			
Sunding 1972	*Ammophiletea; Ammophiletalia; Traganion moquinii;* ***Euphorbio-Cyperetum capitati***; ***Traganetum moquinii***			*Salicornietea futicosae; Chenoletalia; Chenoleion;* ***Chenoleo-Suaedetum mollis***; ***Chenoleo-Suaedetum mollis atractyletosum***
Esteve 1983	***Polycarpaeo-Lotetum kunkelii nomen nudum***			
Santos 1983	*Zygophyllo-Polycarpaetea*			
	Zygophyllo-Polycarpaetalia			*Chenoletalia; Chenoleion*
	Zygophyllion fontanesii	*Traganion moquinii*		
Pérez & Acebes-Ginovés 1983	***Elymus farctus*** **community**; ***Suaedo-Limonietum***			
Del Arco & Wildpret 1983	*Ammophiletea; Ammophiletalia;* ***Ononido-Cyperetum capitati***			
Del Arco & Wildpret 1991		*Pegano-Salsoletea; Forsskaoleo-Rumicetalia; Traganion moquinii;* ***Frankenio-Zygophylletum gaetuli***		
Rivas et al. 1993	*Ammophiletea; Ammophiletalia; Agropyro-Minuartion; Euphorbio-Cyperetum; Ononido-Cyperetum*	*Pegano-Salsoletea; Forsskaoleo-Rumicetalia; Traganion moquinii; Traganetum moquinii*		
Biondi et al. 1994	*Ammophiletea; Ammophiletalia; Agropyrion juncei;* ***Euphorbio-Cyperetum zygophylletosum***; ***Euphorbio-Cyperetum atriplicetosum glaucae***	*Helichryso-Crucianelletea; Helichryso-Crucianelletalia; Ononido-Polycarpion;* ***Launaeo-Ononidetum***; ***Launaeo-Ononidetum suaedetosum***	*Pegano-Salsoletea; Forsskaoleo-Rumicetalia;*	
			Traganion moquinii; Traganetum moquinii	*Launaeo-Schizogynion;* ***Chenoleo-Suaedetum suadetosum verae***
Gehú & Biondi 1996	*Euphorbio-Ammophiletea*	*Pegano-Salsoletea*		
	Ammophiletalia; Sporobolo-Elymenion farcti; Euphorbio-Cyperetum	*Zygophyllo-Polycarpetalia; Ononido-Polycarpion*	*Chenoletalia; Traganion moquinii; Traganetum moquinii*	
Rodríguez et al. 1998	*Ammophiletea; Ammophiletalia*		*Pegano-Salsoletea*	
	Agropyro-Minuartion; Comunidad de Elymus farctus; Euphorbio-Cyperetum cyperetosum; Euphorbio-Cyperetum atriplecetosum; Euphorbio-Cyperetum zygophylletosum; Ononido-Cyperetum capitatii; Polycarpo-Lotetum lancerottensis	*Ononido-Polycarpion; Launaeo-Ononidetum typicum; Launaeo-Ononidetum suadetosum; Suaedo-Limonietum*	*Traganion moquinii; Chenoleo-Suaedetum mollis typicum; Chenoleo-Suaedetum mollis atrctyletosum; Chenoleo-Suaedetum mollis suaedetosum; Frankenio-Zygophylletum gaetulum; Tragantum moquinii*	

Table 1a

Author	Psammophilous scrub	Halo-psammophilous scrub	Halo-nitrophilous scrub
Rodríguez et al. 2000	*Ammophiletea; Ammophiletalia; Agropyro-Minuartion; Euphorbio-Cyperetum capitati*	*Pegano-Salsoletea; Forsskaoleo-Rumicetalia*	
		Traganion moquinii; Frankenio-Zygophylletum gaetuli; Polycarpaeo-Lotetum lancerottensis; Traganetum moquinii	*Launaeo-Schizogynion; Chenoleo-Suaedetum mollis*
Reyes-Betancort et al. 2001	*Ammophiletea; Ammophiletalia; Agropyrion juncei; Euphorbio-Cyperetum;* ***Euphorbio-Cyperetum*** **variant with** ***Senecio leucanthemifolium***	*Pegano-Salsoletea; Forsskaoleo-Rumicetalia*	
		Traganion moquinii; ***Polycarpaeo-Lotetum lancerottensis lotetosum****;* ***Polycarpaeo-Lotetum lancerottensis ononidetosum****; Traganetum moquinii*	*Launaeo-Schizogynion; Chenoleoideo-Suaedetum mollis;* ***Chenoleoideo-Salsoletum vermiculatae****;* ***Cenchro-Launeetum arboreae***
Rivas-Martínez et al. 2001	*Polycarpaeo-Traganetea; Zygophyllo-Polycarpaetalia niveae*		*Pegano-Salsoletea*
	Polycarpaeo-Euphorbion paraliae; Euphorbio-Cyperetum	*Traganion moquinii; Frankenio-Zygophylletum gaetuli; Polycarpaeo-Lotetum lancerotensis; Suaedo-Limonietum; Traganetum moquinii*	*Chenoletalia; Chenoleion; Chenoleo-Suaedetum mollis; Chenoleoideo-Salsoletum vermiculatae*
Brandes 2001		*Polycarpaeo-Traganetea; Zygophyllo-Polycarpaetalia niveae; Traganion moquinii;* ***Convolvulus caput medusae-Ononis natrix*** **ssp.** ***ramossisima*** **community***;* ***Convolvulus caput-medusae-Ononis natrix*** **ssp.** ***ramossisima*** **community variant with** ***Artemisia reptans***	*Pegano-Salsoletea; Chenoletalia; Chenoleion;* ***Chenoleo-Salsoletum vermiculatae*** **variant with** ***Convolvulus caput-medusae***
Scholz et al. 2003		*Polycarpaeo-Traganetea; Zygophyllo-Polycarpaetalia niveae; Traganion moquinii;* ***Polycarpaeo-Pulicarietum burchardii***	
Rivas-Martínez 2011	*Polycarpaeo-Traganetea; Zygophyllo-Polycarpaetalia niveae*		*Pegano-Salsoletea; Chenoleoidetalia tomentosae; Chenoleoidion tomentosae; Chenoleo-Suaedetum mollis; Chenoleoideo-Salsoletum vermiculata*
	Polycarpaeo-Euphorbion paraliae; Euphorbio-Cyperetum; Polycarpaeo-Lotetum	*Traganion moquinii; Frankenia-Zygophylletum gaetuli; Suaedo-Limonietum; Traganetum moquinii; Polycarpaeo-Pulicarietum burchardii*	

Table 1b

Author	Therophyte psammophilous plant communities	
	Stellarietea; Chenopodio-Stellarienea;Brometalia rubenti-tectorum; Carrichthero-Amberboion *Helianthemetea; Malcolmietalia; Ononidion tournefortii*	
Gehú & Biondi 1996		*Ononido-Cyperetum capitati*
Rodríguez et al. 2000	***Launaeo-Resedetum***	
Reyes-Betancort et al. 2001	***Bupleuro-Mairetetum microspermae***	
Scholz et al. 2014	***Bupleuro-Mairetietum microspermae*** **variant with** ***Ononis catalinae***	

Table 1c

Author	Ecotonic plant communities			
	Pegano-Salsoletea; Forsskaoleo.Rumicetalia; Launaeo-Schizogynion; Lygeo-Stipetea; Hyparrhenietalia podotrichae; Saturejo-Hyparrhenion; Kleinio-Euphorbietea; Kleinio-Euphorbietalia; Euphorbion regisjubae-lamarckii; Plocamenion pendulae; Nerio-Tamaricetea; Tamaricetalia; Tamaricion boveano-Canariensis			
García-Casanova et al. 1996		***Cenchro-Hyparrhenietum hirtae eremopogonetosum***		
Brullo et al. 1997		***Tricholaeno-Hyparrhenietum hirtae***; *Eremopogo-Hyparrhenietum hirtae*		
Rivas et al. 2001	*Cenchro-Launaeetum arboreae*			
Rivas 2011	*Cenchro-Launaeetum arboreae*			
Nova hoc loco	***Launaeo-Schizogynetum glaberrimae cyperetosum***		***Plocametun pendulae cyperetosum***	***Atriplici-Tamaricetum cyperetosum***

Table 1d

Author	Nitro-psammophilous grassland *(Cakileteamaritimae; Cakiletalia integrifoliae; Cakilion maritimae)*
Rivas et al. 1993	*Salsolo-Cakiletum maritimae*
Biondi et al. 1994	Group of *Cakile maritima*
Gehú & Biondi 1996	*Salsolo-Cakiletum maritimae*
Rodríguez et al. 1998	*Salsolo-Cakiletum maritimae*
Rodríguez et al. 2000	*Salsolo-Cakiletum maritimae*
Reyes-Betancort et al. 2001	*Salsolo-Cakiletum maritimae*
Rivas-Martínez et al. 2001	*Salsolo-Cakiletum maritimae*
Salas-Pascual & Naranjo-Cigala 2003	*Salsolo-Cakiletum maritimae*

plot sizes is twofold: due to the low density of individuals of different species in the same community, it is necessary to cover a large area in order to cover all their biodiversity; and due to the large size of some species present in these communities, such as *Tamarix canariensis* or *Traganum moquinii*, so that, in order to cover complete specimens or several of them, it was necessary to delimit parcels of that size.

The cover of each plant species was recorded using the cover-abundance scale of Braun-Blanquet. Among the 33 plant communities studied, relevés were available for 32 because *Polycarpaeo-Lotetum kunkelii* was cited without a corresponding example and therefore is considered a *nomen nudum* (Weber et al., 2000). These 32 plant communities are presented in Table 2 and consist of 336 relevés. To these plant communities were added six more associations that are closely related to the psammophilous Canarian vegetation due to their distribution along the same costal fringe, thereby being subject to similar ecological conditions. Furthermore, many of the species that are considered typical of psammophilous vegetation (for example, *Polycarpaea nivea* or *Tetraena fontanesii*) also characterize these plant communities. Therefore, their inclusion in the analysis allowed us to evaluate if they are, indeed, characteristic of one of these types of vegetation. These associations were plant communities of the coastal cliffs, integrated into *Crithmo-Limonietea* (plant communities 17, 18, and 20 in Table 2) and those of the coastal salt marshes, characteristic of *Salicornietea fruticosae* (plant communities 32, 36, and 37 in Table 2). In total, we worked with 427 databased relevés.

It was necessary to employ relevés distinct from those used in the description of syntaxa for two plant communities: plant community 19 and plant community 31. For plant community 19, *Frankenio-Zygophylletum gaetuli*, we used a table of three relevés published by Rodríguez et al. (2000), including the original relevé that defined this association prepared by Del Arco and Wildpret in 1991. For plant community 31, *Salsolo-Cakiletum maritimae*, which is the only plant community not endemic to the Canary Islands or the Selvagens Islands, we used 18 relevés from Fuerteventura, Lanzarote, and Gran Canaria, published by Rodríguez et al. (2000), Reyes-Betancort et al. (2001), and Salas-Pascual & Naranjo-Cigala (2003), respectively.

For the preparation of a table that would allow us to study the similarity between the different associations described, we have made an important taxonomic effort to unify the names of the taxa because many of the species used in these relevés have experienced significant nomenclatural changes. We have relied on the List of Terrestrial Canarian Species published in 2010 (Acebes-Ginovés et al., 2010). In addition to the unification of the nomenclature, it was also necessary to change the names of some species incorrectly listed in the relevés. Among these errors, we highlight the case of *Ononis tournefortii* in the Maspalomas dunes (Gran Canaria), often cited as *Ononis serrata*. A detailed analysis of the populations of this species allowed us to know that *O. serrata* is not found in the Maspalomas dunes and to determine that its references should actually be assigned to *O. tournefortii*.

Results and Discussion

Relative to the role of different taxa as species typical of psammophilous vegetation, the results of the frequency of record of each taxon in the different relevés and plant communities is presented in Table 3. This table shows only the taxa that represent 2% cover or more in one or more groups of vegetation shown in the Table 1. In the 427 analysed relevés, a total of 166 species or subspecies were recorded, but only 49 of them met the 2% criterion for average cover in any group. The species or subspecies that did not meet this threshold could not be considered typical of any of the inventoried types of vegetation because their presence was very limited.

The condition of each taxon typical for each vegetation group is described below, based on Tables 3. Species that are strongly linked to a given plant community or group are considered phytosociological characteristics of that type of vegetation (Braun-Blanquet, 1979)—that is, in order to be considered as such, the species must appear frequently and reach a certain abundance level in the plant communities they characterize, and they must be absent or very rare in others.

The species with high frequency indices in a single type of plant community and, therefore, serve as potential characteristic species are as follows:

- In the coastal cliffs: *Limonium pectinatum*, *Astydamia latifolia*, *Frankenia ericifolia*, and *Reichardia ligulata*.
- In the salt marshes: *Suaeda vera*, *Arthrocnemum macrostachis*, *Halimione portulacoides*, *Sarcocornia perennis*, *Limonium papillatum*, and *Limonium ovalifolium*.
- In the psammophilous plant communities: *Cyperus capitatus*, *Euphorbia paralias*, *Polygonum maritimum*, *Polygonum balansae*, *Ononis tournefortii*, *Salsola kali*, *Cakile maritima*, *Pulicaria burchardii* subsp. *burchardii*, *Elymus farctus* and *Traganum moquinii*.
- Other species such as *Salsola vermiculata*, *Suaeda mollis*, *Herniaria fontanesii*, *Convolvulus caput-medusae*, *Salsola tetandra*, *Tetraena gaetula*, *Suaeda ifniensis* and *Atractylis preauxiana* appear almost exclusively in plant communities of rocky nitrophilous areas, without sand or with surface sand.
- Finally, the plant communities of therophytes, settled on more or less stabilized sands, are characterized by the abundance of species such as *Launaea nudicaulis*, *Reseda crystallina*, *Ononis catalinae*, *Schismus barbatus*, and *Mairetis microsperma*. These plants can also be present in other types of vegetation that are always part of the herbaceous strata.

There is a large group of species that appear frequently in most of the associations studied, regardless of their ecology. These species are *Frankenia capitata*, *Tetraena fontanesii*, and *Polycarpaea nivea*, which have cover values greater than 2% in the plant communities of the coastal cliffs, salt marshes, and nitrophilous shrub communities, psammophytic or not. This ecological amplitude makes it very difficult to consider these species as characteristics of any of these situations, even though they had been considered as such previously (Rivas-Martínez et al., 2011). The constancy of these species in all of these types of vegetation has led to much of the confusion between plant communities associated with different environments. *Frankenia capitata* is a plant that abounds in plant communities of the sunniest and less rainy coastal cliffs, integrated into *Chrithmo-Limonietea*. It is also very common in salt marshes and in rocky coastal areas and halo-nitrophilous plant communities of *Chenoleoidetalia* and even in vegetation of more or less stabilized and windy sands. It has been considered a characteristic species of some associations described in these environments, such as *Frankenio capitatae-Zygophylletum gaetuli*, *Polycarpaeo-Lotetum lancerottensis*, and *Polycarpaeo niveae-Pulicarietum burchardii*. The same happens with *Tetraena fontanesii*, a plant characteristic of the edges of coastal lagoons, coastal cliffs and, less frequently, in psammophilous plant communities. This is a plant that

Table 2. Plant communities analysed. (Explanation in text)

#	List	Plant Community	Reference
1	1-9	*Atriplici-Tamaricetum cyperetosum*	Nova hoc loco
2	10-18	*Bupleuro semicompositi-Mairetetum microspermae*	Reyes-Betancort et al., 2001
3	19-26	*Bupleuro semicompositi-Mairetetum microspermae* variant with *Ononis catalinae*	Scholz et al., 2014
4	27-31	*Cenchro ciliaris-Hyparrhenitum hirtae eremopogonetosum foveolatus*	García-Casanova et al., 1996
5	32-44	*Cenchro ciliaris-Launaetum arborescentis*	Reyes-Betancort et al., 2001
6	45-92	*Chenoleo-Salsoletum vermiculatae*	Reyes-Betancort et al., 2001
7	93-104	*Chenoleo-Suaedetum mollis atractyletosum*	Sunding, 1972
8	105-119	*Chenoleo-Suaedetum mollis typicum*	Sunding, 1972
9	120-133	*Chenoleo-Suaedetum mollis* variant with *Convolvulus caput-medusae*	Brandes, 2001
10	134-142	*Convolvulus caput-medusae-Ononis natrix* ssp. *ramossisima* comunity	Brandes, 2001
11	143-149	*Convolvulus caput-medusae-Ononis natrix* ssp. *ramossisima community* variant with *Artemisia reptans*	Brandes, 2001
12	150-152	*Elymus farctus* community	Pérez & Acebes-Ginovés, 1977
13	153-172	*Euphorbio-Cyperetum capitati*	Sunding, 1972
14	173-175	*Euphorbio-Cyperetum capitati atriplicetosum*	Biondi et al.,1994
15	176-181	*Euphorbio-Cyperetum capitati* variant with *Senecio leucanthemifolius*	Reyes-Betancort, 1998
16	182	*Frankenio capitatae-Suaedetum verae*	Rivas-Martínez et al., 2002
17	183-210	*Frankenio capitatae-Zygophylletum fontanesii*	Rivas-Martínez et al., 1993
18	211-217	*Frankenio capitatae-Zygophylletum fontanesii suaedetosum verae*	Rodríguez et al., 2000
19	221-225	*Frankenio capitatae-Zygophylletum gaetuli*	Del Arco & Widpret, 1991
20	221-240	*Frankenio ericifoliae-Astydamietum latifolia*	Lohmeyer & Trautmann, 1970
21	241-243	*Launaeo arborescentis-Ononidetum ramosissimae suaedetosum vermiculatae*	Biondi et al., 1994
22	244-250	*Launaeo arborescentis-Ononidetum ramosissimae typicum*	Biondi et al., 1994
23	251-256	*Launaeo nudicaulis-Resedetum lancerotae*	Rodríguez et al., 2000
24	257-264	*Launaeo arborescentis-Schizogynetum cyperetosum*	Nova hoc loco
25	265-277	*Ononido-Cyperetum capitati*	Del Arco et al., 1983
26	278-283	*Plocametum pendulae cyperetosum*	Nova hoc loco
27	284-300	*Polycarpaeo niveae-Pulicarietum burchardii*	Scholz et al., 2003
28	301-315	*Polycarpaeo-Lotetum lancerottensis*	Esteve, 1968
29	316-326	*Polycarpaeo-Lotetum lancerottensis lotetosum*	Reyes-Betancort et al., 2001
30	327-341	*Polycarpaeo-Lotetum lancerottensis ononidetosum*	Reyes-Betancort et al., 2001
31	342-359	*Salsolo-Cakiletum maritimae*	Rodríguez et al., 2000; Reyes-Betancort et al., 2001; Salas-Pascual & Naranjo-Cigala, 2003
32	360-367	*Sarcocornietum perennis*	Fernández & Santos, 1983
33	368-380	*Suaedo-Limonietum callibotryi*	Pérez & Acebes-Ginovés, 1977
34	381-393	*Traganetum moquinii*	Sunding, 1972
35	394-403	*Tricholaeno teneriffae-Hyparrhenietum hirtae*	Brullo et al., 1997
36	404-418	*Zygophyllo fontanesii-Arthrocnemetum macrostachyi*	Fernández & Santos, 1983
37	419-420	*Zygophyllo fontanesii-Suaedetum verae*	Biondi et al., 1994
38	421-422	*Zygophyllum fontanesii-Euphorbia paralias* community	Wildpret, 1970
39	423-427	*Zygophyllum fontanesii-Polycarpaea nivea* community	Wildpret, 1970

Table 3. Number and percentage of relevés and plant communities, in which the most significant species of the studied relevés are present.

Taxon	Relevés	%	Plant communities	%
Polycarpaea nívea	174	40.75	26	66.67
Launaea arborescens	173	40.52	26	66.67
Frankenia capitata	156	36.53	24	61.54
Heliotropium ramosissimum	148	34.66	23	58.97
Tetraena fontanesii	120	28.10	24	61.54
Lycium intricatum	89	20.84	17	43.59
Cyperus capitatus	84	19.67	12	30.77
Helianthemum canariensis	72	16.86	10	25.64
Salsola vermiculata	72	16.86	7	17.95
Ononis hesperia	71	16.63	12	30.77
Lotus lancerottensis	64	14.99	12	30.77
Cenchrus ciliaris	58	13.58	11	28.21
Euphorbia paralias	52	12.18	10	25.64
Launaea nudicaulis	49	11.48	14	35.90
Ononis tournefortii	48	11.24	12	30.77
Sueda vera	44	10.30	10	25.64
Schizogyne sericea	41	9.60	8	20.51
Limonium pectinatum	41	9.60	6	15.38
Plantago coronopus	38	8.90	6	15.38
Reseda crystallina	31	7.26	5	12.82
Astydamia latifolia	29	6.79	4	10.26
Mairetis microsperma	29	6.79	6	15.38
Ifloga spicata	27	6.32	7	17.95
Traganum moquinii	26	6.09	6	15.38
Polygonum maritimum	23	5.39	7	17.95
Arthrocnemum macrostachyum	21	4.92	2	5.13
Cakile maritima	20	4.68	4	10.26
Salsola kali	20	4.68	5	12.82
Medicago laciniata	20	4.68	4	10.26
Limonium papillatum	16	3.75	2	5.13
Tamarix canariensis	13	3.04	4	10.26
Salsola tetrandra	13	3.04	3	7.69
Suaeda ifniensis	13	3.04	1	2.56
Plocama pendula	12	2.81	4	10.26
Hyparrhenia hirta	12	2.81	3	7.69
Bupleurum semicompositum	12	2.81	2	5.13
Tricholaena tenerifae	11	2.58	1	2.56
Senecio leucanthemifolius	10	2.34	3	7.69
Sarcocornia perennis	9	2.11	2	5.13
Lolium parabolicae	9	2.11	2	5.13
Schizogyne glaberrima	9	2.11	3	7.69
Tetraena gaetula	8	1.87	2	5.13
Aristida adsencionis	8	1.87	2	5.13
Ononis catalinae	8	1.87	1	2.56
Eremopogon foveolatus	6	1.41	2	5.13
Schismus barbatus	6	1.41	2	5.13
Elymus farctus	5	1.17	2	5.13
Tetrapogon villosum	3	0.70	2	5.13

indicates the existence of high salinity in the substrate or the environment, and it disappears as the marine influence or salinity of the substrate is reduced.

Polycarpaea nivea is also present in coastal cliffs and salt marshes but with much less frequency than the previous two species, although it is present in halo-nitrophilous plant communities, psammophytic or not.

There exists a large group of plants showing high frequencies in psammophilous plant communities and in the halo-nitrophilous plant communities of stony soils, while they are absent or very rare in the rest of analysed plant communities: *Launaea arborescens*, *Cenchrus ciliaris*, *Atriplex glauca* subsp. *ifniensis*, *Heliotropium ramosissimum*, *Schizogyne sericea*, and *Chenoleoides tomentosa*. In this group, we also could include *Polycarpaea nivea*.

The main problem of the phytosociological classification of the Canarian psammophilous vegetation is the lack of characteristic species because those noted so far have such broad ecological valence that they also appear in non-psammophilous plant communities. Thus, while plant communities that occupy deep sands are strictly psammophytic, the same is not true for those located on surface sands, where the floristic differences are not significant when compared to other plant communities in non-sandy substrates (e.g., associations dominated by *Salsola vermiculata*). We must add the halo-nitrophilous character of most of the Canarian coastal ecosystems, including those occupied by sandy substrates. This complexity has led to different approaches over the last decades in the phytosociological characterization of the psammophilous vegetation of the Canary Islands. The initial idea proposed by Esteve (1968) consisted of the inclusion in *Euphorbio-Ammophiletea* of all Canarian coastal plant communities settled on sand. However, from the beginning, the difficulty in separating psammophilous communities from other plant communities also located on stony ground covered with a certain amount of sand was appreciated.

The present idea (Rivas-Martinez, 2011) largely repeats that posited by Santos (1983) such that it is based on the existence of an endemic class in the Macaronesian territory, *Polycarpaeo-Traganetea*, instead of on *Euphorbio-Ammophiletea*. However, the initial problem is still present because there are few species characteristics of this class to behave as truly psammophilous but merely tolerant of the presence of sand. The characteristic species of the class mentioned by the author are *Polycarpaea nivea* and *Tetraena fontanesii* (Rivas-Martinez, 2011). As we discussed earlier, *Polycarpaea nivea* has been considered characteristic of *Euphorbio-Ammophiletea*, *Pegano-Salsoletea*, and *Polycarpaeo-Traganetea*, and it is also present in the plant communities of *Crithmo-Limonietea*. The other species considered characteristic of the class, *Tetraena fontanesii*, has an even broader ecological valence than the previous species. It is present and abundant in salt marshes, coastal cliffs, and almost any type of vegetation that is exposed to salt spray or high levels of soil or groundwater salinity. This species does not bear the excessive presence of sand, therefore being absent on dunes and aeolian sedimentary systems with large volumes of sediment, and it may appear in the dune fields associated with wet slacks with highly saline groundwater (Hernández-Cordero et al., 2006; Hernández-Cordero et al., 2015a).

In addition, the class *Polycarpaeo-Traganetea* would be integrated by strictly psammophilous associations, characterized by elements of *Euphorbio-Ammophiletea*: *Euphorbia paralias*, *Cyperus capitatus*, *Polygonum maritimum*, *Pancratium maritimum*, *Calystegia soldanella*, etc.—i.e., non-endemic, together with other plant communities not exclusively linked to sandy substrates—and with even less relationship to areas with sediment mobility, with a large proportion of endemic or indigenous species shared with the nearby African coast, elements closely related to the *Pegano-Salsoletea* class (Géhu & Biondi, 1996 & 1998).

This also happens with the various alliances to be integrated into this class. Santos (1983) and Rivas-Martinez (2011) suggest the separation of a hypothetical Canarian psammophilous class into two alliances, but they attend to different issues. Santos (1983) differentiates between the two alliances according to their more or less psammophytic natures, whereas Rivas-Martinez (2011) raises differences in the biotype, separating low shrubland from "open associations of small size". The size of a formation is a somewhat ambiguous feature not uniform in all associations included by the authors in the same alliance. In the analysis performed, we can see that there is still significant confusion over the identification of some plant communities as psammophilous.

A problem repeatedly raised is the *Polycarpaeo-Lotetum lancerottensis* association (Sunding, 1972; Reyes-Betancort et al., 2001). This was the first plant community to have been described that tries to gather in a single association most of the psammophilous plant communities of the coast of Gran Canaria, Fuerteventura, and Lanzarote (Esteve, 1968); it therefore included a large number of species with very different ecological values between the relevés used to describe it. An additional problem is the lack of typification of this association, which is very difficult given the heterogeneity of the relevés that provided its definition. In addition, as indicated by Sunding (1972), there exists in this association a taxonomic problem created by Esteve (1968), who considered *Lotus lancerottensis* to be present in Gran Canaria but who then confused it with *Lotus arinagensis* and *Lotus kunkelii*, both endemic species from the island of Gran Canaria. A solution to this taxonomic problem was offered many years later by Esteve (1983), who suggested the name *Polycarpaeo-Lotetum kunkelii* for the association in Gran Canaria. However, it was not clear whether the new name should also apply to plant communities of Lanzarote and Fuerteventura, nor was any relevé suggested as nomenclatural *typus*; thus, no author has considered this name of *Polycarpaeo-Lotetum kunkelii* to be validly published. An interesting discussion on this subject is raised by Reyes-Betancort et al. (2001), and although they largely coincide with the criticism of Sunding (1972), they raise the possibility of keeping the name proposed by Esteve (1968).

On the other hand, there are some specific syntaxa on the dunes of southern Morocco, such as *Polycarpaeo niveae-Euphorbietum paraliae* and *Euphorbio paraliae-Ononidetum tournefortii* (Géhu and Biondi, 1996; Géhu, 1998), that could be assimilated into plant communities identified in some aeolian sedimentary systems of the Canary Islands (Hernández-Cordero et al., 2015c). However, more detailed studies would be needed to confirm this proposal.

Conclusions

Psammophilous vegetation of Canary Islands is very diverse with a ranging from therophyte plant communities to medium size scrubs, with large differences depending of sand stability, the presence of salt in the substrate, the degree of nitrification, etc. It is very difficult to integrate all of this diversity into one or a few phytosociological classes.

Knowledge that is as accurate as possible on the ecology of the species and the ecological role of plant communities are two requirements that seem increasingly essential for the correct definition of the syntaxa, especially in regard to ecotone plant communities or being settled in places with very specific ecological requirements, as the psammophilous communities, hygrophilous communities, etc. In other words, to properly describe syntaxa, the identification of the characteristic species is very important, with less attention to their presence or even to the abundance of species with a broad ecological role. Furthermore, it is important that the described syntaxa have concrete placement in the vegetational dynamics of the terrain, thereby avoiding the definition of associations on ecotone zones.

As a final conclusion, this paper proposes the following syntaxonomical scheme for the psammophilous plant communities of the Canary Islands, formed by 10 classes, 26 associations, and 9 sub-associations, where 9 classes, 14 associations, and 5 sub-associations are more or less psammophilous plant communities. Moreover, three new psammophilous sub-associations were defined to group the ecotone plant communities by different types of vegetation and their psammophilous vegetation. The strict psammophilous plant communities are indicated by adding (*) at the end of its name, whereas facultative psammophilous associations are indicated by (**).

A. *Helianthemetea guttati* (Br.-Bl. in Br.-Bl. et al. 1952) Rivas Goday & Rivas-Martínez 1963 em. Rivas-Martínez 1978; *Malcolmietalia* Rivas Goday 1958; *Ononidion tournefortii* Géhu et al. 1996

1. ***Ononido tournefortii-Cyperetum capitati*** Wildpret et al. in Del Arco et al. 1983 (*)
Although this syntaxon was defined only for an artificial beach on the island of Tenerife (Del Arco et al., 1983), it has been identified in several dune systems of the Canary Islands, as in Maspalomas, and it occupies part of the island of La Graciosa (Hernández-Cordero et al., 2015a; Hernández-Cordero et al., 2015c). They are therophyte subnitrophilous or eutrophilous plant communities that colonize semi-stabilized and stabilized inland dunes without any marine influence or dunes closer to the coast with limited marine influence because the shape of the coast does not favour the dispersion of salt spray landward. *Cyperus capitatus* is a differential species in these plant communities, and it is characteristic of *Euphorbio-Ammophiletea*.

B. *Stellarietea mediae* Tüxen et al. ex von Rochow 1951; *Chenopodio-Stellarienea* Rivas Goday 1956; *Thero-Brometalia* (Rivas Goday & Rivas-Martínez ex Esteve 1973) Bolòs 1975; *Resedo lanceolatae-Moricandion* F. Casas & Sánchez 1972
2. ***Launaeo nudicaulis-Resedetum lancerotae*** O. Rodríguez et al. 2000 (**)

3. ***Bupleuro semicompositi-Mairetietum microspermae*** Reyes-Betancort et al. 2001
Variant with *Ononis catalinae* (**)
They are nitrophilous ephemeral grasslands, maintained either by extensive grazing or by natural causes, such as the slow mineralization of organic matter experienced in these soils of arid areas. Missing much of the year, they dramatically grow up after the autumn rains. A significant number of therophytes are characteristic of this plant community, but *Launaea nudicaulis*, *Lotus glinoides*, *Reseda crystallina*, *Plantago coronopus*, *Plantago afra* and *Ifloga spicata* are especially common. They are not exclusive to sandy soils.

C. *Cakiletea maritimae* Tüxen & Preising ex Br.-Bl & Tüxen 1952; *Cakiletalia integrifoliae* Tüxen ex Oberdorfer 1949 corr. Rivas-Martínez et al. 1992; *Cakilion maritimae* Pignati 1953

4. ***Salsolo kali-Cakiletum maritimae*** Costa & Mansanet 1981 (*)
Therophyte ephemeral community exclusive from nitrified deep sandy areas near the coast, where *Salsola kali* and *Cakile maritima* are prevailing. In the Canary Islands, this association does not have any different characteristic species.

D. *Euphorbio paraliae-Ammophiletea australis* Géhu & Rivas-Martínez in Rivas Martínez 2011
The name *Euphorbio paraliae-Ammophiletea australis* was first used by Géhu and Géhu-Frank (1988) and was corrected by Géhu (1998). These names are not validly published for lack of nomenclatural type (art. 5 CINF, 2003).
Characteristic species present in the Canary Islands: *Cyperus capitatus*, *Euphorbia paralias*, *Polygonum maritimum*, *Pancratium maritimum*, and *Calystegia soldanella*.
Phytosociological classes group graminoid perennial plant communities and small shrubs of coastal dunes, according to the authors that have defined it (Rivas-Martínez, 2011; Géhu & Géhu-Frank, 1988). In our opinion, the most eminently psammophilous plant communities found in the Canary Islands should be integrated into this class because, as mentioned before, they share several characteristic species and have similar ecological and dynamic behaviour to this on the Atlantic coast of North Africa or the Mediterranean.
Although this class reaches the Canary Islands only marginally, its plant communities may still be found, well-characterized by the character species of the class, especially *Cyperus capitatus* and *Euphorbia paralias*, although the latter is missing in the inner aeolian sedimentary systems away from the marine influence.
Ammophiletalia australis Br.-Bl. 1933
This is the alliance that can be found in Canarian aeolian sedimentary systems, usually characterized by graminoid hemicryptophyte vegetation but in the Canary Islands is also represented by shrub plant species, characteristic of mobile primary dunes or those in a stabilization process.

Ammophilion australis (*arundinaceae*) Br.-Bl. 1921 corr. Rivas-Martínez et al. in Rivas-Martínez et al. 1990

This alliance integrates the sourhernmost plant communities of the alliance, Mediterranean, and Mediterraneo-Atlantic.

Elytrigienion junceae Rivas-Martínez, Costa, Castroviejo & E. Valdés 1980

Suballiance defined for embryonic dunes and dune ridges, where the Canarian associations are included (Géhu, 1998).

5. ***Elymus farctus*** (=*Agropyrum junceiforme*) community (*)
Despite this plant community's being invalidly published (art. 3 CINF), it is interesting to note that it constitutes a very interesting representation of this class in the area of the Canary Islands. This plant community, described for the Selvagens Islands, is present in deep sand deposits,

very nitrofiled and with high salt content, which leads to an abundance of salt marsh species such as *Suaeda vera*, which relates this plant community to other vegetation types. A better definition of this association is necessary.

6. ***Euphorbio-Cyperetum capitati*** Sunding 1972
6. a. ***typicum*** (*)

[=*Polycarpaeo-Lotetum lancerottensis* Esteve 1968 *nomen dubium* (art. 37); =*Polycarpaeo-Lotetum kunkelii* Esteve 1983 *nom. inval*. (art. 3o); =*Zygophyllum fontanesii-Euphorbia paralias* community Wildpret 1970 nom. inval. (art. 3b)]

6.b. ***atriplicetosum glaucae*** Biondi et al. 1994 (*)

[=*Polycarpaeo-Lotetum lancerottensis* Esteve 1968 *lotetosum* Reyes-Betancort et al. 2001 *nom. inval*. (art. 4); =*Zygophyllum fontanesii-Polycarpaea nivea* community Wildpret 1970 *nom. inval*. (art. 3b)]

Euphorbio-Cyperetum capitati develops in coastal dunes with marine influence. When sand thickness is low and sediment mobility is reduced, the subassociation *atriplicetosum* is found, which connects the plant communities of this class with those halo-nitrophilous communities less dependent on a sandy substrate. In this subassociation, characteristic species of *Pegano-Salsoletea* occur, especially *Polycarpaea nivea*, *Atriplex glauca* subsp. *ifniensis*, *Chenoleoides tomentosa* and various species of the genus *Lotus* (*Lotus lancerottensis*, *Lotus arinagensis*, *Lotus kunkelii*, *Lotus sessilifolius*). We think that these ecotonal locations have often been designated as *Polycarpaeo-Lotetum lancerottensis*, a name we discard as ambiguous (*nomen dubium*, art.37, Weber et al. 2000).

Traganion moquini Sunding 1972
7. ***Traganetum moquini*** Sunding 1972 (*)
The *Traganum moquinii* community is included in this class because the dunes where this shrub species is settled have active aeolian sedimentary processes. It is located at the waterfront (where it creates the foredune), around the interior areas, and also in the slacks (Hernández-Cordero et al., 2015c). It is a pioneer species that colonize the dunes in areas with high soil moisture, forming dunes by the sand accretion generated by its root system (Hernández-Cordero et al., 2015b). Therefore, it is a species that has a similar ecological role to the one played by *Ammophila arenaria* in European coasts (Sunding, 1972; Hernández-Cordero et al., 2015c). In areas with high aeolian sedimentary activity (where the input of sand and dune mobility is greater), it forms monospecific plant communities, but in areas with lower aeolian sedimentary activity, *Traganum moquinii* is accompanied by typical species of the floristic cortege of this class. For this reason, the correlation analysis conducted in this paper grouped this plant community with the remaining strictly psammophilous plant communities.

E. *Pegano harmalae-Salsoletea vermiculatae* Br.-Bl. & O. Bolòs 1958
Forsskaoleo angustifoliae-Rumicetalia lunariae Rivas-Martínez et al. 1993; *Launaeo arborescentis-Schizogynion sericeae* Rivas-Martínez et al. 1993

8. ***Launaeo arborescentis-Schizogynetum glaberrimae*** *ass. nova hoc loco*
8.a. **cyperetosum capitati** *subass. nova hoc loco* (*)

9. ***Cenchro ciliaris-Launaeetum arborescentis*** Reyes-Betancort et al. 2001 (**)
Chenoleoidetalia tomentosae Sunding 1972 nom mut.; *Chenoleoidion tomentosae* Sunding 1972 nom. mut.

10. ***Chenoleoideo tomentosae-Suaedetum mollis*** Sunding 1972 nom. mut.
10.a. ***typicum***
10.b. ***atractyletosum preauxii*** Sunding 1972

11. ***Chenoleoideo tomentosae-Salsoletum vermiculatae*** Reyes-Betancort et al. 2001 (**)

12. ***Frankenio capitatae-Zygophylletum gaetuli*** Del Arco & Wildpret 1991 (*)

13. ***Polycarpaeo niveae-Pulicarietum burchardii*** Scholz et al. 2003 (*)

14. ***Launaeo arborescentis-Ononidetum hesperiae*** Biondi et al. 1994 *corr. hoc loco*
[=*Polycarpaeo niveae-Lotetum lancerottensis* subass. *ononidetosum hesperiae* (Biondi et al. 1994) Reyes-Betancort et al. 2001 nom. inval. (art. 4)]
14.a. ***typicum*** (*)
14.b. ***suadetosum mollis*** Biondi et al. 1994 *corr. hoc loco* (**)

In the present study, as previously discussed, class *Polycarpaeo niveae-Traganetea moquini* Santos ex Rivas-Martínez & Wildpret 2002 is not considered. It seems more appropriate to keep in the Canaries the presence of *Euphorbio-Ammophiletea*, including in this class the strongly psammophilous associations characterized by species that are also exclusively arenicolous and to keep within *Pegano-Salsoletea* the nitro-psammophilous communities that get established on fixed dunes or with a fine sand cover, in contrast to species that can grow on sand or on other types of substrates.
The species that characterize this association, *Launaea arborescens* and *Ononis hesperia*, are not exclusively psammophilous.

The nitrophilous scrubs included in this class play an important role in Canarian psammophilous vegetation. It is important to note that the presence of sand in most of these plant communities is an important but not decisive factor, so it is often possible to find the same plant community in areas where there is a surface layer of sand or even on fossil dunes or in places without sand. The influence of the salt spray is much more important and it determines the floristic composition of these plant communities. Therefore, we can find vegetation types of this class settled on sand in two different situations: in plant communities without marine influence, included in *Forsskaoleo-Rumicetalia* and *Launaeo-Schizogynion sericeae*; and in coastal or inland plant communities subject to strong winds that permit salt spray to penetrate to remote areas of the coast (included in *Chenoleoidetalia tomentosae* and *Chenoleoideon tomentosae*).

Among the former, the warmest and driest nitrophilous scrubs without marine influence are dominated by *Launaea arborescens* and *Schizogyne glaberrima*, for which we describe the new association *Launaeo arborescentis-Schizogynetum glaberrimae*, endemic to Gran Canaria (Table 4, *typus* relevé 15). In the dune fields, they are located in slacks and stabilized dunes (Hernández-Cordero et al., 2015a; Table 4). In the Maspalomas dune system, *Schizogyne glaberrima* loses prominence and *Launaea arborescens* is the dominant species. Their floristic composition changes depending on the type of landform: in the slacks, it consists of species such as *Heliotropium ramosissimum*, *Cenchrus ciliaris*, *Cynodon dactylon*, and *Ononis tournefortii*; in the stabilized dunes *Heliotropium ramosissimum* takes part, and psammophilous species such as *Ononis tournefortii*, *Cyperus capitatus* and the exotic species *Neurada procumbens* are more abundant; for these situations the new subassociation *cyperetosum capitati* is described (Table 4, relevés 17-23, *typus* relevé 17).

The endemic nitrophilous scrubs of southern Gran Canaria described here are dominated by a group of species, among which several are endemic to this island: *Schizogyne glaberrima*, *Asteriscus graveolens* subsp. *stenophyllus*, *Lavandula minutolii* and *Echium decaisnei*, which, along with other characteristic species, such as *Artemisia ramosa*, *Lycium intricatum* and *Launaea arborescens*, result in dense formations of great ecological amplitude, which act both as natural vegetation in places rich in nitrogen salts, as in the bases of cliffs and outermost edges of channels, both replacing a variety of plant communities always in the arid or hyperarid desertic inframediterranean bioclimate (Del Arco et al., 2002). Geographically, *Launaeo arborescentis-Schizogynetum glaberrimae* is found from the sea to 200 m altitude, from Tarajalillo (San Bartolome de Tirajana) to Tasartico (La Aldea de San Nicolás), being endemic to the southern district of the island of Gran Canaria (Salas-Pascual et al., 2015). At higher altitudes, it is replaced by plant communities of the alliance *Artemisio-Rumicion lunariae*.

F. *Nerio oleandri-Tamaricetea* Br.-Bl. & O. Bolòs 1958; *Tamaricetalia* Br.-Bl. & O. Bolòs 1958 em. Izco et al. 1984; *Tamaricion africanae* Rivas-Martínez et al. 2011

15. ***Atriplici ifniensis-Tamaricetum canariensis*** Rivas-Martínez et al. 1993

15.a. **cyperetosum capitati** *subass. nova hoc loco* (*)

16. ***Suaedo verae-Tamaricetum canariensis*** O. Rodríguez et al. 2001

When the dune systems are associated with the mouth of ravines, a singular ecotone between plant communities typical of both situations is established. This fact is evident in the dunes of Maspalomas in southern Gran Canaria, where the dune field is located on an alluvial fan (Hernández-Calvento, 2006), which determines the existence of groundwater at shallow depths that becomes accessible to plants in the slacks (Hernández-Cordero et al., 2015b). This explains the presence of a hygrophilous species such as *Tamarix canariensis* in the Maspalomas dune field, the only one of the Canary Islands where this taxon is abundant and representative of its vegetation. In this environment, the *Tamarix canariensis* community of southern Gran Canaria establishes an ecotone with dunes, both mobile and stabilized, and when the dunes burial the individuals of *Tamarix canariensis*, give place to the new subassociation *cyperetosum capitati* (Table 5, relevés 5-11; *typus* relevé 5). In this situation, the *Tamarix canariensis* community is enriched with dune species such as *Heliotropium ramosissimum*, *Cyperus capitatus*, and *Ononis tournefortii* and the neophyte *Neurada procumbens*. In mobile dunes it may lack floristic courtship (Table 5, relevés 11-13). In both cases they form the subassociation *Atriplici ifniensis-Tamaricetum canariensis* subass. *cyperetosum capitati*.

These plant communities are different from the *Tamarix canariensis* community present in the eastern islands and east of Gran Canaria, where *Suaeda vera* accompanies *Tamarix canariensis*, resulting in the association *Suaedo verae-Tamaricetum canariensis*, normally found at ravine beds and mouths of ravines with a deep clayey soil rich in salts (Table 5, relevés 1-4).

G. *Kleinio neriifoliae-Euphorbietea canariensis* (Rivas-Goday & Esteve 1965) Santos 1976; *Kleinio neriifoliae-Euphorbietalia canariensis* (Rivas-Goday & Esteve 1965) Santos 1976; *Euphorbion regisjubo-lamarckii* Rivas-Martínez et al. 2011; *Plocamenion pendulae* Rivas-Martínez et al. 2011

17. ***Plocametum pendulae*** Marrero et al. 2003

17.a. **cyperetosum capitati** *subass. nova hoc loco* (*)

This subassociation is the ecotone between plant communities dominated by *Plocama pendula* and the dune system.

Table 4. *Launaeo arborescentis-Schizogynetum glaberrimae ass. nova*. subass. *typicum* (relevés 1-16) and *cyperetosum capitati subass. nova* (relevés 17-24) (*Launaeo arborescentis-Schizogynion sericeae*; *Forsskaoleo angustifoliae-Rumicetalia lunariae*; *Pegano harmalae-Salsoletea vermiculatae*).

Relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15*	16	17**	18	19	20	21	22	23	24
Altitude (m.a.s.l.)	10	20	100	70	15	170	40	120	3	100	60	75	90	70	70	120	12	9	7	20	14	9	9	30
Slope (°)	5	10	.	20	20	15	70	50	20	30	10	20	.	10	.	10	0	0	8	15	29	5	0	80
Exposure	E	SW	.	SE	N	SE	SW	NW	W	S	SE	SE	.	SW	NE	S	NE	NW	NW	NW	SW	SW	SW	NW
Area (m²)	200	200	200	200	100	150	100	200	100	50	200	200	200	100	100	150	100	100	100	100	100	100	100	45
Cover (%)	80	90	60	80	70	60	40	40	40	80	80	95	90	90	90	70	50	50	80	80	60	50	30	100
Number of species	5	10	18	8	12	11	9	9	10	13	11	9	12	10	10	7	4	7	5	4	7	10	9	10
Characteristic taxa																								
Launaea arborescens	3	1	2	3	3	1	3	3	1	1	2	1	2	3	3	3	3	3	5	2	1	+	+	2
Schizogyne glaberrima	2	4	2	4	3	1	2	2	2	3	4	5	2	3	4	4	.	.	.	.	.	1	+	.
Lycium intricatum	.	+	.	2	+	.	2	.	.	1	1	.	1	.	.	1	.	.	.	.	.	.	.	2
Heliotropium ramosissimum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	+	.	+	2	1	2
Lavandula minutolii	.	.	1	.	.	.	1	2	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.
Suaeda mollis	1	2	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Echium decaisnei	.	.	+	.	1	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia ramosa	.	.	.	.	1	3	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Forsskaolea angustifolia	.	.	1	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Asteriscus graveolens	.	.	.	.	.	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Atriplex glauca	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ceballosia fructicosa	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schizogyne sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
Subassociation differentials																								
Ononis tournefortii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	3	1	1	1	1
Neurada procumbens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	1	2	.	.	.
Cyperus capitatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	+	2	+	.	.	.
Companions																								
Cenchrus ciliaris	.	1	1	.	.	.	.	.	.	2	3	+	5	2	2	.	.	2	.	.	3	1	.	.
Tricholaena teneriffae	.	+	.	.	2	1	1	+	1		1	.	1	2	1	.	.	.	.	.	.	.	.	.
Patellifolia patellaria	.	.	1	.	.	.	.	.	.	1	2	+	+	.	.	+	.	.	.	.	.	.	+	+
Aizoon canariensis	.	.	+	.	+	.	+	1	+	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.
Cynodon dactylon	.	.	.	.	.	.	.	.	.	.	1	.	3	1	.	.	.	2	1	.	.	2	.	.
Atriplex semibaccata	2	.	.	1	+	.	.	.	.	1	1	.	1	.	.	1	.	.	.	.	.	.	.	.
Fagonia cretica	.	1	1	.	.	.	.	.	.	.	.	1	.	1	1	+	.	.	.	.	.	.	.	1
Plocama pendula	.	3	.	1	1	.	1	+	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
Nicotiana glauca	3	.	.	.	2	2	.	.	+	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Pennisetum setaceum	.	.	2	.	.	.	.	.	+	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.
Aristida adcensionis	.	.	.	.	+	+	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Kleinia neriifolia	.	.	1	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	1
Opuntia dillenii	.	.		.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1
Volutaria canariensis	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	2	1	.
Rumex vesicarius	.	.	1	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Echium triste	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Hyparrhenia sinaica	.	.	.	.	.	2	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Euphorbia balsamifera	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Maireana brevifolia	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Argyranthemum filifolium	.	.	.	1	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Lobularia lybica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.

Other species.- In 2: *Neochamaelea pulverulenta* +; in 3: *Cuscuta planiflora* +. *Carrichtera annua* +; in 5: *Conyza sumatrensis* +; in 6: *Kickxia scoparia* 1. *Tetrapogon villosus* +; in 8: *Euphorbia regis-jubae* 1. *Helianthemum canariensis* +; in 9. *Astydamia latifolia* 1. *Reichardia ligulata* +; in 12. *Mercurialis annua* +; in 13. *Phagnalon purpurescens* +. *Wahlenbergia lobelioides* +; in 18. *Mairetis microsperma* 1. *Anthoxanthum aristatum* 1; in 22. *Tamarix canariensis* +; in 23. *Mesembryanthemum crystallinum* 1. *Mesembryanthemum nodiflorum* + **Localities and dates**.- 1: Llanos de Meloneras. 27º 44´ 31´´ N; 15º 36´ 13´´ W (31.03.2001); 2. Low rooming at Montaña Alta. S. B. de Tirajana. 27º 45´ 55´´ N; 15º 36´ 15´´ W (03.04.2001); 3: Barranco de Mogán. 27º 49´ 49´´ N; 15º 45´ 17´´ W (12.02.2016); 4: Barranco de la Tabaquera. S.B. de Tirajana. 27º 46´ 09´´ N; 15º 38´ 07´´ W (12.2.2016); 5. La Maleza. S.B. De Tirajana. 27º 45´ 58´´ N; 15º 33´ 41´´ W (24.03.2001); 6. Rampa Tabaibales. Lomo del Paso del Rey. 27º 50´ 07´´ N; 15º 46´ 16´´ W (1.5.2001); 7. Between Veneguera and Los Secos. Punta del Varadero. 27º 51´ 07´´ N; 15º 47´ 40´´ W (05.05.2001); 8. Between Veneguera and Los Secos. Lomo de Las Canteras. 27º 50´ 58´´ N; 15º 47´ 34´´ W (05.05.2001); 9. Playa de Guigui Chico. 27º 56´ 55´´ N; 15º 49´ 39´´ W (17.6.2001); 10. Barranco de Fataga. 27º 46´ 37´´ N; 15º 35´ 11´´ W (12.02.2016); 11. Barranco de Fataga. 27º 46´ 55´´ N; 15º 35´ 07´´ W (12.02.2016); 12. Barranco de Palmitos Park. 27º 46´ 20´´ N; 15º 36´ 04´´ W (12.02.2016); 13. Barranco de Arguineguín. 27º 49´ 06´´ N; 15º 39´ 51´´ W (12.2.2016); 14. Barranco de Tiritaña. 27º 48´ 39´´ N; 15º 44´ 41´´ W (12.02.2016); 15*. Barranco de Tiritaña. 27º 48´ 39´´ N; 15º 44´ 39´´ W (12.02.2016). *typus association*; 16. Barranco de la Tabaquera. San Bartolomé de Tirajana. 27º 46´ 09´´ N; 15º 38´ 03´´ W (12.02.2016); 17**. Dunas de Maspalomas. 27° 44' 45" N; 15° 35' 30" W (07.04.2005). *typus subassociation*; 18. Dunas de Maspalomas. 27° 44' 40" N; 15° 35' 23" W (12.04.2005); 19. Dunas de Maspalomas. 27° 44' 41" N; 15° 34' 52" W (13.05.2005); 20. Dunas de Maspalomas. 27° 44' 52" N; 15° 34' 56" W (27.04.2005); 21. Dunas de Maspalomas. 27° 44' 53" N; 15° 34' 46" W (22.04.2005); 22. Dunas de Maspalomas. 27° 44' 45" N; 15° 35' 16" W (26.04.2005); 23. Dunas de Maspalomas. 27° 44' 54" N; 15° 34' 47" W (10.05.2005); 24. Duna de Guanarteme. 28º 07´ 48´´ N; 15º 26´ 17´´ W (10.2.2016)

When the water table present in the ravine beds is not as shallow as to allow the existence of the gallery forest dominated by *Tamarix canariensis*, this bed is occupied by a plant community characterized by the Canarian endemism *Plocama pendula*. This plant community may be associated with coastal dune systems, such as at the mouth of the Fataga ravine. The characteristics species of *Euphorbio-Ammophiletea* and *Malcolmietalia* (*Cyperus capitatus* and *Ononis tournefortii*) differentiate the psammophilous new subassociation of this plant community (Table 6, type relevé 2). Phytosociologically, the plant communities with *Plocama pendula* are integrated into a single association, *Plocametum pendulae*, for which three subassociations have been defined so far, one for each island where it appears: *euphorbietosum lamarckii* in Tenerife, considered by its authors as the typical subassociation; *euphorbietosum regis-jubae* in Gran Canaria; and *euphorbietosum berthelotii* in La Gomera (Marrero-Gómez et al., 2003).

The subassociation we define in this paper is currently only present in Gran Canaria, specifically, in the Mapalomas dune system (Hernández-Cordero et al., 2015a), because the ecological conditions that make it possible are given only in this island. It is possible that it was also present in Fuerteventura in the past, but currently, *Plocama pendula* is a rare species on that island.

H. *Lygeo sparti-Stipetea tenacissimae* Rivas-Martínez 1978; *Hyparrhenietalia hirtae* Rivas-Martínez 1978; *Hyparrhenion sinaicae* Br.-Bl. et al. 1956 corr. J.C. Costa et al. 2001

18. ***Cenchro ciliaris-Hyparrhenietum sinaicae*** Wildpret & O. Rodríguez in Rivas-Martínez et al. 1993 corr. Díez Garretas & Asensi 1999
    18.a. ***eremopogonetosum foveolati*** García-Casanova et al. 1996 (**)

[=*Eremopogo foveolati-Hyparrhenietum hirtae* Brullo et al. 1997]

19. ***Tricholaeno-Hyparrhenietum hirtae*** Brullo et al. 1997 (**)

[=*Cenchro ciliaris-Hyparrhenietum hirtae* Wildpret & O. Rodríguez in Rivas-Martínez et al. 1993 subass. *tricholaenetosum teneriffae* Wildpret & O. Rodríguez in Rivas-Martínez et al. 1993]

These facultatively psammophilous associations dominated by perennial graminoid species (*Hyparrhenia hirta*, *Hyparrhenia sinaica*, *Cenchrus ciliaris*) can occur on volcanic or marine sands. Their distinction is floristic and also bioclimatic: whereas the former, characterized by the presence of *Eremopogon foveolatus*, occupies xeric and desertic conditions, the latter, characterized by *Tricholaena teneriffae*, appears in semiarid to arid conditions and has a broader distribution, reaching the Italian coast (Brullo et al., 1997).

For the comparative analysis performed in this paper, especially for defining the characteristic species of Canarian psammophilous plant communities, other associations whose phytosociological consideration is presented below have been used in this article.

I. *Crithmo maritimi-Limonietea* Br.-Bl. in Br.-Bl et al. 1952; *Crithmo maritimi-Limonietalia* Molinier 1934; *Frankenio ericifoliae-Astydamion latifoliae* Santos 1976

20. ***Frankenio ericifoliae-Zygophylletum fontanesii*** Rivas-Martínez et al. 1993 corr. Santos 2002
21. ***Frankenio ericifoliae-Astydamietum latifoliae*** Lohmeyer & Trautmann 1970

These plant communities occupy the areas closest to the coast, where marine influence is more intense. They are characterized by the presence of *Frankenia ericifolia*, *Frankenia capitata*, *Astydamia latifolia*, several species of the genus *Limonium*, particularly *Limonium pectinatum*, and *Polycarpaea nivea*, and *Tetraena fontanesii* are prevalent there.

J. *Sarcocornietea fruticosae* Br.-Bl. & Tüxen ex A. & O. Bolòs 1950; *Sarcocornietalia fruticosae* Br.-Bl. 1933; *Sarcocornion fruticosae* Br.-Bl. 1933; *Sarcocornienion perennis* Rivas-Martínez in Rivas-Martínez et al. 1980

22. ***Sarcocornietum perennis*** F. Galván & Santos 1984

Arthrocnemion macrostachyi Rivas-Martínez & Costa 1984 *Arthrocnemenion macrostachyi* (Rivas-Martínez & Costa 1984) Rivas-Martínez & Costa in Rivas-Martínez et al. 2011

23. ***Zygophyllo fontanesii-Arthrocnemetum macrostachyi*** F. Galván & Santos 1984

Suaedion verae (Rivas-Martínez et al. 1990) Rivas-Martínez et al. 1999

24. ***Frankenio capitatae-Suaedetum verae*** Reyes-Betancort et al. 2002
25. ***Zygophyllo fontanesii-Suaedetum verae*** Biondi et al. 1994

26. ***Suaedo-Limonietum callibotryi*** Pérez de Paz & Acebes-Ginovés in Acebes-Ginovés & Pérez de Paz 1985 (**)

The vegetation of Canarian salt marshes needs a detailed review, especially those plant communities dominated by the species *Suaeda vera*, which have been cited in the islands within several different associations. The presence of sand on substrate where the association *Suaedo-Limonietum callibotryi* grows in the Great Selvagen Island has allowed this plant community to be consider as psammophilous. It is actually a scrub dominated by *Suaeda vera* and *Limonium papillatum* var. *callibotryum*, a local endemism from Selvagens Islands with a wider ecological valence.

Table 5. *Suaedo verae-Tamaricetum canariensis* (relevés 1-4) (*Tamaricion africanae. Tamaricetalia. Nerio-Tamaricetea*). *Atriplici ifniensis-Tamaricetum canariensis* (relevés 5-20) *cyperetosum capitati subass. nova* (relevés 5-13). *tamaricetosum* (relevés 14-20) (*Tamaricion africanae. Tamaricetalia. Nerio-Tamaricetea*). Legend for the substrate: 1. Clayey soil; 2. Dry sand (dune); 3. Stony-claye

Relevé	1	2	3	4	5*	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Substrate	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
Alitude (m.a.s.l.)	2	2	2	1	16	15	12	2	10	15	11	4	3	5	10	5	0	24	70	5
Slope (º)	.	.	.	.	13	38	35	.	.	15	32	6	0	.	.	.	.	.	.	.
Exposure	.	.	.	.	NE	NW	SW	.	.	S	SE	SW	SE	.	.	.	.	NW	.	.
Area (m^2)	100	200	100	150	200	400	100	100	200	200	100	100	100	50	200	200	200	200	200	200
Cover (%)	90	80	80	100	80	80	100	90	90	60	80	70	100	100	95	95	90	100	100	100
Number of species	6	6	7	3	10	11	6	7	9	7	1	1	1	9	10	10	16	5	5	7
Character taxa																				
Tamarix canariensis	4	2	2	4	4	4	5	3	4	3	5	4	5	5	5	4	5	5	5	5
Differentials of *Suaedo verae-Tamaricetum canariensis*																				
Suaeda vera	1	4	4	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tetraena fontanesii	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Frankenia capitata	+	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Suaeda maritima	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Differentials of *Atriplici ifniensis-Tamaricetum canariensis cyperetosum capitati*																				
Cyperus capitatus	.	.	.	.	2	2	2	+	+	+	.	.	.	.	.	.	.	.	.	.
Neurada procumbens	.	.	.	.	+	1	2	+	1	+	.	.	.	.	.	.	.	.	.	.
Ononis tournefortii	.	.	.	.	2	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Companions of *Pegano-Salsoletea*																				
Launaea arborescens	.	.	.	.	2	2	2	2	2	4	.	.	.	1	2	2	1	.	.	+
Suaeda mollis	1	2	2	.	.	.	.	2	.	.	.	.	.	2	1	.	.	.	.	.
Schizogyne glaberrima	.	.	.	.	.	.	.	2	3	1	.	.	.	2	3	.	.	.	.	.
Atriplex glauca subsp. *ifniensis*	.	1	1	.	.	.	.	.	.	.	.	.	.	3	.	.	1	.	.	3
Lycium intricatum	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	+	1	.	+	.
Schizogyne sericea	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	+	.
Heliotropium ramosissimum	.	.	.	.	.	.	1	1	+	+	.	.	.	.	.	.	.	.	.	.
Hygrophyte companions																				
Juncus acutus	.	.	.	2	.	.	.	.	3	.	.	.	.	.	.	.	.	2	3	2
Phoenix canariensis	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.
Companions																				
Nicotiana glauca	+	.	.	.	.	.	.	.	1	+	.	.	.	.	1	.	.	.	.	+
Atriplex semibaccata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	+	3	.	.	3
Patellifolia patellaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	4	.	.	.
Sonchus oleraceus	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Patellifolia webbiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	.	.
Arundo donax	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.
Plocama pendula	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Anthoxanthium aristatum	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aizoon canariensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
Chenopodium murale	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Other species.- In 6. *Mesembryanthemum crystallinum* 2. *Cenchrus ciliaris* 2; in 14. *Cynodon dactylon* 2. *Forsskaolea angustifolia* +. *Phagnalon saxatile* +; in 15. *Volutaria canariensis* 1; in 16. *Ricinus communis* 1; in 17. *Mesembryanthemum nodiflorum* 4. *Launaea nudicaulis* +. *Astydamia latifolia* +. *Sonchus tenerrimus* +. *Spergularia bocconei* +. *Pennisetum setaceum* +. *Salsola divaricata* +. *Beta macrocarpa* +; in 18. *Fagonia cretica* 1; in 19. *Polypogon monspeliensis* +; in 20. *Phragmites australis* 1. *Limonium pectinatum* +.
Localities and date.- 1: Little ravine below la Peña del Medio Mundo.Jinámar. 28º 01´ 57´´ N; 15º 24´ 01´´ W (18.03.2016); 2: Playa de Vargas. 27º 53´ 04´´ N; 15º 23´ 39´´ W (05.09.2001); 3: Barranquillo de la Punta. Pozo Izquierdo. 27º 48´ 59´´ N; 15º 27´ 17´´ W (29.08.2001); 4: Juncalillo del Sur. 27º 47´ 42´´ N; 15º 28´ 49´´ W (01.2001); 5*: Dunas de Maspalomas. 27° 44' 36" N; 15° 35' 28" W (05.04.2005) (*typus* subassociation); 6: Dunas de Maspalomas. 27° 44' 42" N; 15° 35' 37" W (07.04.2005); 7: Dunas de Maspalomas. 27° 44' 47" N; 15° 34' 46" W (10.05.2005); 8. 9. 10 y 15: Oasis de Maspalomas. 27º 44´ 28´´ N; 15º 35´ 49´´ W (24.03.2001); 11: Dunas de Maspalomas. 27° 44' 32" N; 15° 34' 48" W (07.07.2005); 12: Dunas de Maspalomas. 27° 44' 36" N; 15° 34' 51" W (26.05.2005); 13: Dunas de Maspalomas. 27° 44' 24" N; 15° 34' 50" W (08.07.2005); 14: Bahía Feliz. 27º 46´ 50´´ N; 15º 31´ 22´´ W (26.02.2001); 16: Barranco de Veneguera mouth. 27º 56´ 06´´ N; 15º 47´ 25´´ W (05.05.2001); 17: El Risco (Agaete). 28º 03´ 12´´ N; 15º 44´ 19´´ W (17.04.2016); 18. Playa de La Caleta (Agaete). 28º 06´ 29´´ N; 15º 31´ 22´´ W (17.04.2016); 19. Barranco del Juncal (Agaete). 28º 06´ 58´´ N; 15º 42´ 05´´ W (17.04.2016); 20: Charco de La Aldea. 28º 00´ 05´´ N; 15º 59´ 04´´ W (05.07.2001).

Table 6. *Plocametum pendulae* (relevés 1-12) *cyperetosum capitati subass. nova* (relevés 1-6). subass. *euphorbietosum regis-jubae* (relevés 7-12) (*Plocamenion penduale. Euphorbion regisjubo-lamarckii. Kleinio neriifoliae-Euphorbietalia canariensis. Kleinio neriifoliae-Euphorbietea canariensis*)

Relevé	1	2*	3	4	5	6	7	8	9	10	11	12
Altitude (m. a.s.l.)	16	20	20	15	12	10	180	50	16	10	30	10
Slope (º)	.	.	.	.	6	10	5	5	10	5	10	.
Exposure	.	.	.	.	S	NE	SE	SO	E	SE	SO	.
Area (m^2)	200	200	100	200	100	200	100	200	200	150	200	200
Cover (%)	60	60	50	80	60	70	70	80	50	80	70	40
Number of species	8	8	6	4	9	6	9	18	14	12	12	9
Character taxa												
Plocama pendula	3	3	2	4	2	3	3	4	3	3	4	3
Euphorbia regis-jubae	.	.	.	.	.	.	2	1	1	1	1	.
Kleinia neriifolia	.	.	.	.	.	.	1	1	+	1	.	.
Neochamaelea pulverulenta	.	.	.	.	.	.	.	2	.	.	+	.
Euphorbia canariensis	.	.	.	.	.	.	.	.	.	.	1	.
Euphorbia balsamifera	.	.	.	.	.	.	.	1	.	.	.	.
Micromeria tenuis subsp. *tenuis*	.	.	.	.	.	.	.	1	.	.	.	.
Periploca laevigata	.	.	.	.	.	.	.	1	.	.	.	.
Rubia fruticosa	.	.	.	.	.	.	.	+	.	.	.	.
Argyranthemum filifolium	.	.	.	.	.	.	.	+	.	.	.	.
Differentials of the subass. *cyperetosum capitati*												
Cyperus capitatus	.	2	1	1	2	3	.	.	.	.	.	.
Ononis tournefortii	2	2	1	.	1	1	.	.	.	.	.	.
Neurada procumbens	2	2	2	.	2	2	.	.	.	.	.	.
Companion taxa												
Launaea arborescens	2	2	1	3	2	4	1	2	1	2	2	2
Cenchrus ciliaris	+	.	.	+	.	.	1	.	1	1	1	.
Hyparrhenia sinaica	.	.	.	.	.	.	+	1	1	1	2	.
Tricholaena teneriffae	.	.	.	.	.	.	.	1	.	2	1	1
Echium decaisneis	.	.	.	.	.	.	.	2	.	1	2	.
Mairetis microsperma	1	1	.	.	2	.	.	.	.	.	.	.
Heliotropium ramosissimum	.	1	+	.	1	.	.	.	.	.	.	.
Nicotiana glauca	.	.	.	.	1	1	.	.	.	.	.	+
Lavandula minutolii	.	.	.	.	.	.	.	1	1	.	+	.
Plantago cf. *phaeostoma*	+	+	.	.	1	.	.	.	.	.	.	.
Aizoon canariensis	.	.	.	.	.	.	.	+	1	.	.	+
Pennisetum setaceum	.	.	.	.	.	.	.	.	.	3	.	2
Schizogyne glaberrima	.	.	.	.	.	.	.	2	.	.	.	1
Volutaria canariensis	.	.	.	.	.	.	.	.	.	+	1	.

Other species.- In 1: *Cutandia* cf. *menphitica* +; in 7: *Argemone mexicana* 1. *Echium onosmifolium* 1. *Parolinia ornata* +; in 8: *Asteriscus graveolens* subsp. *stenophyllus* 1. *Ononis angustissima* +; in 9: *Schizogyne sericea* 2. *Suaeda mollis* 2. *Polycarpaea nivea* 1. *Convolvulus caput-medusae* 1. *Opuntia dillenii* 1. *Reseda scoparia* 1; in 10: *Tetrapogon villosus* 1. *Forsskaolea angustifolia* +; in 11: *Kickxia scoparia* +; in 12: *Echium triste* subsp. *triste* +. *Patellifolia patellaris* (+).

Localities and date.- 1. 2* (*typus* of *Plocametum pendulae* subas. *cyperetosum capitati*). 3 & 4: Dunas de Maspalomas. 27º 44´ 43-45´´ N; 15º 35´ 21-32´´ W (20.03.2016); 5: Dunas de Maspalomas. 27° 44' 39'' N; 15° 35' 28'' W (14.04.2005); 6: Dunas de Maspalomas. 27º 44´ 42´´ N; 15º 35´ 30´´ W (24.03.2001); 7: Barranco de Tirajana (s.d) (Marrero et al. 2003. table II. inv. 9. *typus* of *Plocametum pendulae* subass. *euphorbietosum regis.jubae*); 8: Barranco del Perchel. Mogán. 27º 50´ 04´´ N; 15º 46´ 34´´ W (01.05.2001); 9: Barranco de Tasartico. 27º 55´ 13´´ N; 15º 48´ 36´´ W (09.06.2001); 10: Barranco de Guayadeque. 27º 54´ 54´´ N; 15º 27´ 13´´ W (05.09.2001); 11: Punta de Tarajalillo. San Bartolomé de Tirajana. 27º 47´ 04´´ N; 15º 30´ 49´´ W (26.09.2001); 12: Bajo Morrete de la Sardina. San Bartolomé de Tirajana. 27º 49´ 48 N; 15º 29´ 35´´ W (26.02.2001).

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