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Soil and Phytosociological Characterisation of Grasslands in the Western Mediterranean

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Abstract

A study was made of grasslands in olive groves with a high frequency of *Hordeum leporinum* Link, *Chrysanthemum coronarium* L., *Malva neglecta* Wallr., *Aegilops geniculata* Roth and *Dasypyrum villosum* (L.) Borbas, initially included in the alliance *Hordeion leporini* Br.-Bl. in Br.-Bl., Gajewski, Wraber & Walas 1936 corr. O. Bolós 1962, and sub-alliance *Malvenion neglectae* Gutte 1966. The study was carried out in the western Mediterranean (Spain, Italy, Portugal and northern Morocco). The soil and phytosociological treatment of the samples contributes information for new plant communities. In the study of plant communities, the indices of degree of presence are adapted to those of Van der Maarel. The new alliance *Securigero securidacae-Dasypyrion villosi* is proposed for the sub-Mediterranean and Euro-Siberian territories, with the new communities *Securigero securidacae-Dasypyretum villosi* and *Convolvulo elegantissimi-Aegilopetum geniculatae*. This last community, due to its richness in *Aegilops geniculata* Roth, could be included in the alliance *Taeniathero-Aegilopion geniculatae* Rivas-Martínez & Izco 1977; however, the soil and statistical analyses reveal that it should remain part of the alliance *Securigero securidacae-Dasypyrion villosi.* The soil and floristic study of *Hordeion leporini* and *Malvenion neglectae* allows us to describe the new sub-alliance *Resedo albae-Chrysanthemenion coronarii*, subordinated to *Malvion neglectae* (Gutte 1966) status novo.

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Keywords

Soil, Grassland, Community, Association

1. Introduction

The grassland communities studied are included by various authors [1]-[3], in the alliance Hordeion leporini, which comprises grasslands with a Mediterranean optimum, a sub-nitrophilous or nitrophilous character, and spring growth. This alliance extends throughout the sub-Mediterranean and central European territories. Although it has a Mediterranean optimum, this alliance can be found in Euro-Siberian (centre-European) areas such as the central Pyrenees (Spain) and the central Apennines (Italy), with a presence, in these latter territories and in Italian sub-Mediterranean environments, of species such as *Dasypyrum villosum* (L.) Borbas. These calcicolous species from southeast Europe are frequently found in Italy, and are absent in Spain and Portugal. The same occurs with *Securigera securidaca* (L.) Deg. et Dorfl., whose area of distribution is in southern Europe until southeast France; and *Crepis sancta* (L.) Babc., found in the samples taken in Italy, with a biogeographic area in the eastern Mediterranean region and in southeast Europe. All the communities of *Dasyyirum villosum* (L.) Borbas are grassland formations with dense coverage and considerable biomass which thrive in environments with a high quantity of organic matter [4]. This alliance includes some communities which, due to their structure, floristic composition and soil, should have been included in alliances other than Hordeion leporini. Alliance has been studied by other authors [5]-[10]. The soil parameters condition the presence of plant populations and communities, and this fact can be used to determine the soil nutrients according to the degree of presence and abundance of the species.

2. Material and Methods

Study Area

The territory in the study corresponds to the western Mediterranean (Spain, Italy, Portugal and northern Morocco). The samplings were taken in the spring of 2006. This study was initiated by [6] [7] in Spain and Portugal, and the Italian areas in Umbria and the Puglia region (Gargano) were inventoried by [5]. The communities in the sampling are distributed throughout the western Mediterranean, and the soil samples were taken in Andalusia (Spain), Alentejo (Portugal) and the regions of Umbria and Gargano (Italy) (**Figure 1**). Soil samples were taken of substrates with both acid and basic pH, when the plant community presented a high abundance index of the dominant species.

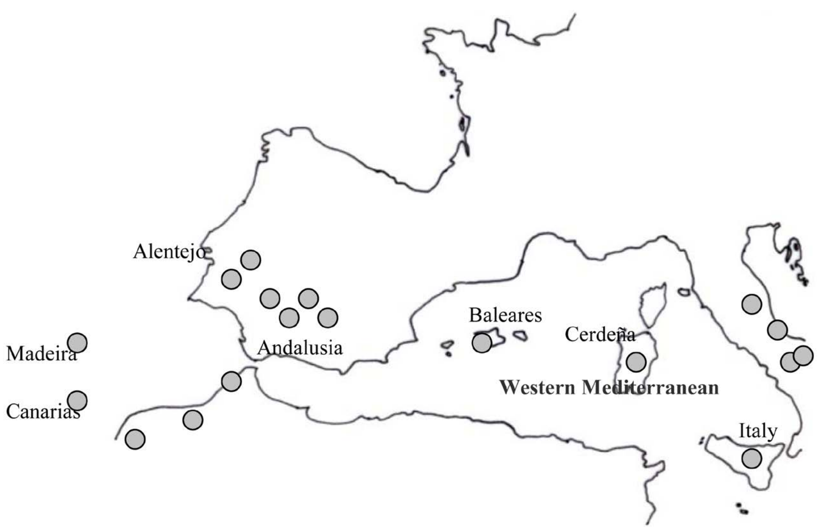

Figure 1. Localisation of soil sampling on the Iberian Peninsula and in Italy.

The floras of [11] and [12], were used for the floristic and phytosociological study, and [13] for the phytosociological methodology. The soil study was done by taking 265 samples of each inventory of 14 plant communities, and the soil sample was obtained from the plant community where the dominant species has a high abundance-dominance index, and at the depth of the root system of each species. 16 soil parameters were analysed in the laboratory: exchangeable calcium (meq/100g), cation exchange capacity (meq/100g), carbonates (%), assimilable phosphorus (p.p.m), exchangeable magnesium (meq/100g), oxidable organic matter (%), total nitrogen (%), pH 1/2.5, exchangeable potassium (meq/100g), pF 1/3 atm. (%), pF 15 atm. (%), electrical conductivity 1/5 (mmhos/cm), clayey texture (%), silty texture (%), sandy texture (%), and exchangeable sodium (meq/100g).

In order to differentiate the communities of *Hordeion leporini* in the western Mediterranean, a synthetic Excel chart was drawn up based on the 74 association tables which include 847 inventories (**Table 1**), and comprise 740 rows (species) × 74 columns (association tables). The degrees of presence used were according to [13], which range from I to V with the following % equivalence: V implies that the degree of presence of the species in the samples taken ranges between 80% and 100%; IV from 60% to 80%, III from 40% - 60%, II from 20% - 40% and I < 20%. In our case we applied the following formula in order to obtain the index value (degree of presence): Ip = n. V/T, where Ip = index of presence; n = number of inventories in the table of the community in which the species is included; V = maximum presence value (the species is included in all the inventories in the community table); T = total number of inventories in the table. Based on this criterion we used the following Ip values; an Ip value of >4.5 is assigned a presence value of V; Ip = 3.5 - 4.5 a value of IV; Ip = 2.5 - 3.5 a value of III; Ip = 1.5 - 2.5: II; and finally Ip < 1.5 is assigned a value of I. Once the synthetic table of the 74 community tables was drawn up, we adapted these indices to the [42]. I = 3; II = 4; III = 5; IV = 6; V = 7.

A cluster was applied to the Excel chart of 740 rows (species) × 74 columns (association tables) with the Jaccard distance, in order to establish the degree of similarity/dissimilarity between the association tables. It was similarly applied to the synthetic species tables for Italy, the Iberian Peninsula and northern Morocco (Spain, Portugal, northern Morocco), which comprise 444 rows × 26 columns and 528 rows × 47 columns respectively, to determine the distance existing between the different associations present in each territory. The previous analysis was corroborated with DECORANA ordination and RA analysis to establish the difference between the groups.

A table of averages was drawn up using the 265 soil samples and a PCA was applied to determine which soil factors condition the presence of the plant community.

In order to differentiate the Italian communities rich in *Dasypyrum villosum* (L.) Borbas, a statistical treatment of conglomerates was performed. This was done by drawing up several Excel charts; one with the 45 phytosociological field samples plus 63 inventories of proximate associations due to their richness in *Dasypyrum villosum* (L.) Borbas (281 rows × 108 columns), to which was subsequently applied a cluster analysis using the Euclidean distance.

In order to determine in which alliance to include the Italian community of *Convolvulus elegatissimus* Miller and *Aegilops geniculata* Roth, two Excel charts were made with the 45 soil and community samples from Italy plus 41 from the Iberian Peninsula which were very similar to the Italian samples in terms of structure and floristic composition, and comprising 16 soil parameters × 86 columns (samples), with subsequent application of cluster and PCA. The 41 Iberian samples belonged to the associations *Trifolio cherleri-Taeniatheretum capitis-medusae* Rivas-Martínez & Izco 1977 (TT) and *Plantago bellardii-Aegilopetum geniculatae* Cano-Ortiz, Pinto Gomes & Cano 2010 (PA), described for Portugal [8].

The data used were included in a synthetic table of presences with 740 rows (species) × 74 association tables, and in a soil table of 265 samples × 16 soil parameters.

3. Results and Discussion

A statistical treatment was performed on 12 of the 16 soil parameters analysed in each one of the 265 samples, as two of the soil parameters obtained did not appear to be relevant (**Table 2**). This allows us to confirm that MOO, Nt and CIC are the factors which have the greatest influence in communities AB, SD and CA present in Italy (Ge1) (**Figure 2** and **Figure 3**), with a lower influence of Pa, Mgc and Kc; conversely in the group of grassland communities present on the Iberian peninsula, TT, LR, ArH, BH, ArChr, PA and ArP, the most relevant factor is texture (Ge2). The edaphic study of 14 communities served to establish the abundance of the do-

Table 1. Associations studied in the western Mediterranean.

Ass	Sintaxon	N. inv.
1	*Bromo scoparii-Hordeetum leporinii* Rivas-Martínez 1978 [2]	17
2	*Bromo scoparii-Hordeetum leporinii* subas. *sisymbrietosum officinalis* Rivas-Martínez 1978 [2]	10
3	*Bromo scoparii-Hordeetum leporinii* subas. *diplotaxietosum catholicae* Rivas-Martínez 1978 [2]	8
4	*Papaveri rhoeadi-Diplotaxietum virgatae* Rivas-Martínez 1978 [2]	11
5	*Papaveri rhoeadi-Diplotaxietum virgatae* Rivas-Martínez 1978 var con *Sisymbrium runcinatum* [2]	5
6	*Papaveri rhoeadi-Diplotaxietum virgatae* Rivas-Martínez 1978 subas. *erucetosum vesicariae* Rivas-Martínez 1978 [2]	2
7	*Papaveri rhoeadi-Diplotaxietum virgatae* Rivas-Martínez 1978 subas. *sisymbrietosum contorti* Rivas-Martínez 1978 [2]	2
8	*Anacyclo radiati-Hordeetum leporini* O. Bolòs & Rivas-Martínez in Rivas-Martínez 1978 [2]	4
9	*Anacyclo radiati-Hordeetum lepronii* O. Bolòs & Rivas-Martínez in Rivas-Martínez 1978 subas. *chrysanthemetosum coronarii* Rivas-Martínez 1978 [2]	5
10	*Anacyclo radiati-Hordeetum leporinii* O. Bolòs & Rivas-Martínez in Rivas-Martínez 1978 subas. *arthocethosum calendulae* Rivas-Martínez 1978 [2]	4
11	*Resedo albae-Chrysanthemetum coronarii* O. Bolòs & Molinier 1958 [Own inventories]	20
12	*Anacyclo radiati-Papaveretum rhoeadis* Cano-Ortiz *et al*. 2009 [6]	20
13	*Anacyclo radiati-Chrysanthemetum coronarii* Rivas-Martínez 1978 & Cano-Ortiz *et al*. 2009 [6]	20
14	*Anacyclo radiati-Hordeetum leporinii* Rivas-Martínez 1978 [Own inventories]	20
15	*Anacyclo clavati-Hordeetum leporinii* Cano-Ortiz *et al*. 2009 [7]	20
16	*Bromo scoparii-Hordeetum leporinii* Rivas-Martínez 1978 [7]	20
17	*Hordeetum leporini* Br. Bl. 1936 [15]	7
18	*Carduo tenuiflori-Hordeetum leporini* Br.-Bl. 1931 [3]	4
19	*Bromo-Hirschfeldietum incanae* Lohmeyer 1975 [16]	7
20	*Sisymbrio officinalis-Hordeetum Marini* Br.-Bl. 1967 subas. *hordeetosum murini* y subas. *anacycletosum clavati* Fernández-González & Sardinero in Sardinero 2004. *Bromo scoparii-Hordeetum leporini* Rivas-Martínez 1978 subas. *sisymbrietosum officinalis* Rivas-Martínez 1978 [17]	13
21	*Resedo albae-Chrysanthemetum coronarii* O. Bolòs & Molinier 1958 [18]	8
22	*Iondrabo auriculatae-Erucetum vesicariae* Rivas-Martínez 1978 [18]	4
23	*Iondrabo auriculatae-Erucetum vesicariae* Rivas-Martínez 1978 [2]	12
24	*Iondrabo auriculatae-Erucetum vesicariae* Rivas-Martínez 1978 subas. *diplotaxietosum virgatae* Rivas-Martínez 1978 [2]	4
25	*Rapistro rugosi-Sisymbrietum crassifolii* Rivas-Martínez 1978 [2]	13
26	*Hordeo leporini-Glossoppapetum macroti* Peinado, Martínez-Parras & Bartolomé 1986 [19]	10
27	*Papaveri rhoeadi-Diplotaxietum virgatae* Rivas-Martínez 1978 [5]	20
28	Co. *Linaria spartea et Raphanum raphanistrum* [9]	24
29	*Raphano raphanistri-Diplotaxietum catholicae* Vicente Orellana & Galán 2008 [20]	9
30	*Asphodelo fistulosi-Hordeetum leporini* A. & O. Bolòs in O. Bolòs 1956 [21]	3
31	*Resedo albae-Chrysanthemetum coronarii* O. Bolòs & Molinier 1958 [22]	5
32	*Resedo albae-Chrysanthemetum coronarii* O. Bolòs & Molinier 1958 [23]	8
33	*Anacyclo radiati-Hordeetum leporini* O. Bolòs & Rivas-Martínez in Rivas-Martínez 1978 [24]	5
34	*Anacyclo radiati-Hordeetum leporini* O. Bolòs & Rivas-Martínez in Rivas-Martínez 1978 [25]	4
35	*Aveno lusitanicae-Hordeetum leporini* Espirito Santo, J. C. Costa, Jardin & Sequeira 2004 subas. *chrysanthemetosum coronari* Capelo *et al*. 2004 [10]	9
36	*Bromo madritensis-Galactitetum tomentosae* O. Bolòs, Molinier & P. Monserrat 1970 [26]	5

Continued

37	*Eruco longirostris-Diplotaxietum erucoidis* Rigual 1972 corr. Alcaraz 1984 [3]	2
38	*Eruco longirostris-Diplotaxietum erucoidis* Rigual 1972 corr. Alcaraz 1984 [21]	4
39	*Asphodelo fistulosi-Hordeetum leporini* A. & O. Bolòs in O. Bolòs 1956 subas. *spergularietosum* Esteve 1972 [27]	14
40	.*Asphodelo fistulosi-Hordeetum leporini* A. & O. Bolòs in O. Bolòs 1956 [28]	13
41	*Anacyclo radiati-Hordeetum leporini* O. Bolòs & Rivas-Martínez in Rivas-Martínez 1978 subas. typicum; subas. *chrysanthemetosum coronarii* Rivas-Martínez 1978 y subas. *notobasetosum syriacae* Galán, Deil, V. Orellana & Müller 2004 [29]	C.11-12
42	*Anacyclo radiati-Hordeetum leporini* O. Bolòs & Rivas-Martínez in Rivas-Martínez 1978 subas. *notobasetosum syriacae* Galán, Deil, V. Orellana & Müller 2004 [29]	C.13
43	*Hordeo leporini-Glossoppapetum macroti* Peinado, Martínez-Parras & Bartolomé 1986 [29]	C.14-15
44	*Sisymbrio irionis-Sinapietum mairei* P. Prieto, Espinosa & S. Fernández 1973 corr. Rivas-Martínez *et al*. 2002 [30]	50
45	*Schismo calycini-Malvetum trifidae* Br.-Bl., Font Quer, G. Br.-Bl., Frey, Jansen & Moor 1936 [14]	1
46	*Euphorbio terracinae-Anacycletum coronati* Reyes, Wildpret & León 2001 [31]	8
47	*Bromo-Hirschfeldietum incanae* Lohmeyer 1975 [31]	6
48	*Aveno barbatae-Brometum diandri* Baldoni & Biondi 1993 [Own inventories]	16
49	*Convolvulo elegantissimi-Aegilopetum geniculatae* Cano-Ortiz, Biondi & Cano nova hoc loco [Own inventories]	11
50	*Securigero securidacae-Dasypyretum villosi* Cano-Ortiz, Biondi & Cano nova hoc loco [Own inventories]	18
51	*Hordeo-Sisymbrietum orientalis* Oberd. 1954 [32]	13
52	*Hordeo-Crepidetum bursifoliae* Brullo, Scelsi & Spanpinato 2001 [32]	13
53	*Centaureetum napifoliae* Brullo 1983 [32]	3
54	*Malvo parviflorae-Chrysanthemetum coronarii* Ferro 1980 [32]	10
55	*Dasypyro-Aegilopetum triuncialis* Brullo, Scelsi & Spanpinato 2001 [32]	5
56	*Malvo parviflorae-Chrysanthemetum coronarii* Ferro 1980 [1]	10
57	*Hypochoerido-Plantaginetum serrariae* Brullo 1983 [1]	14
58	*Centaureetum napifoliae* Brullo 1983 [1]	10
59	*Hordeo-Sisymbrietum orientalis* Oberd. 1954 [1]	12
60	*Hordeo-Senecionetum squalidi* Brullo 1983 [1]	9
61	*Hordeo-Erodietum acaulis* Brullo 1983 [1]	10
62	*Hordeo-Vulpietum ligusticae* Brullo 1983 [1]	6
63	*Carduetum australis* Brullo 1983 [1]	6
64	*Senecioni cosyrensi-Hordeetum leporini* Brullo 1983 [1]	5
65	*Hordeo-Centauretum macracanthae* Brullo 1983 [1]	5
66	*Chrysanthemo-Silybetum mariani* Bullo 1983 [1]	5
67	*Malvo parviflorae-Chrysanthemetum coronarii* Ferro 1980 [33]	19
68	*Lavatero creticae-Chrysanthemetum coronarii* Ferro 2004 [34]	10
69	*Rumici-Carduetum pycnocephali* Kruska 1985 [35]	10
70	*Bromo rigidi-Dasypyretum villosi* Pignati 1953 subas. *brometosum diandri* Biondi *et al*. 1999 [4]	10
71	*Vulpio ligusticae-Dasypyretum villosi* Falleni 1998 [36]	107
72	*Laguro ovati-Dasypyretum villosi* Falleni 1998 [36]	13
73	*Aveno barbatae-Brometum diandri* Baldoni & Biondi 1993 [37]	12
74	*Bromo rigidi-Dasypyretum villosi* Pignati 1953 [11]	20

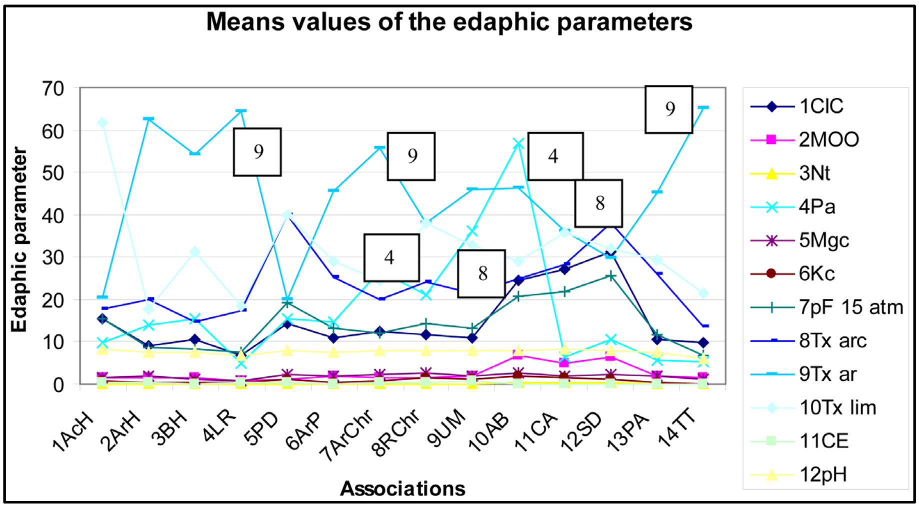

Figure 2. Soil parameters with the greatest influence on plant communities.

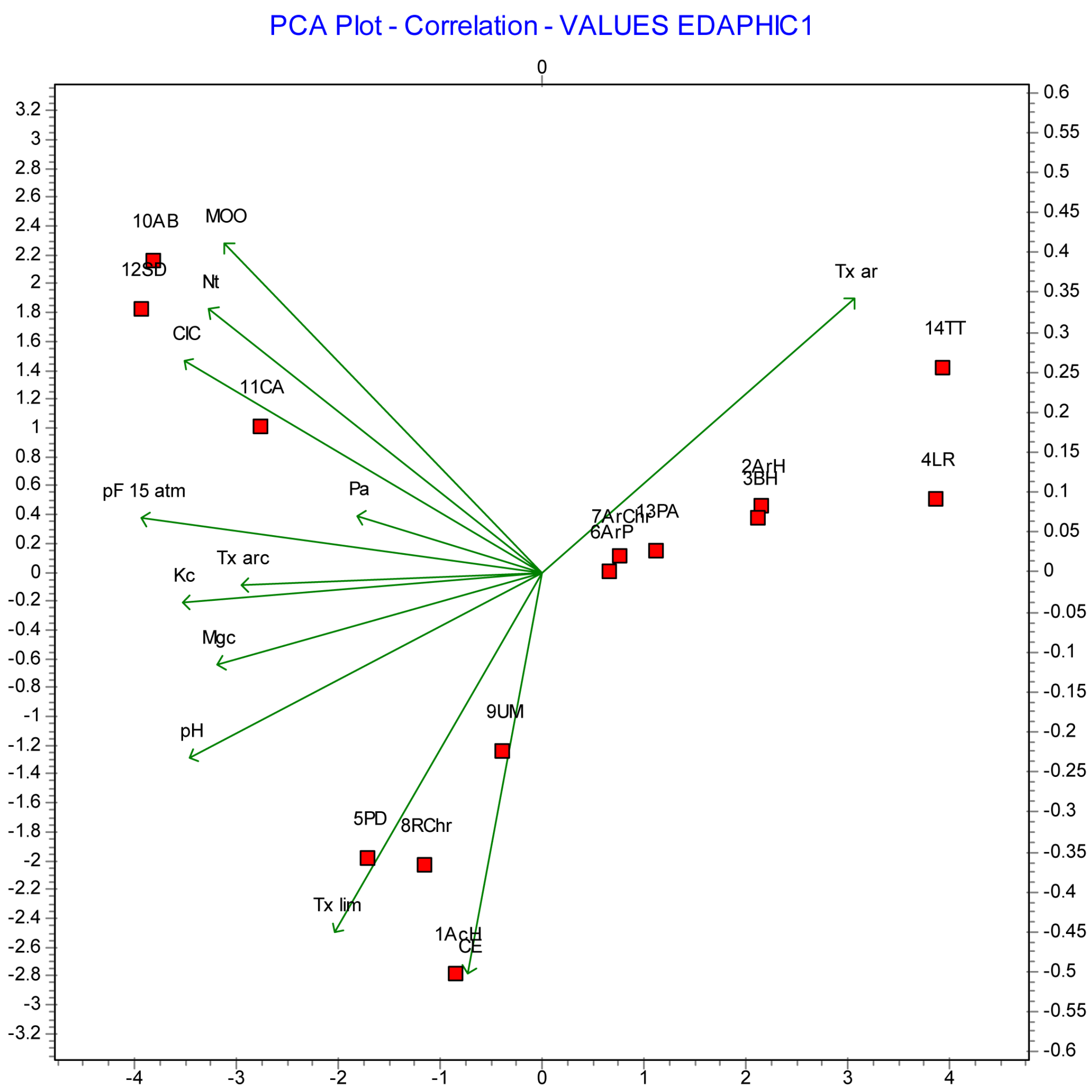

Figure 3. Soil parameters with the greatest influence on plant communities. PCA analysis.

Table 2. Average values of the soil parameters studied.

	1AcH	2ArH	3BH	4LR	5PD	6ArP	7ArChr	8RChr	9UM	10AB	11CA	12SD	13PA	14TT
CIC	15.365	9.131	10.544	6.661	14.304	10.869	12.328	11.68	10.889	24.478	26.99	31.237	10.54	9.63
MOO	1.541	1.56	1.667	0.75	1.02	1.803	1.622	1.574	1.904	6.679	5.002	6.426	1.8	1.458
Nt	0.115	0.102	0.133	0.064	0.09	0.14	0.105	0.129	0.179	0.309	0.216	0.283	0.136	0.084
Pa	9.789	13.957	15.4	4.824	15.35	14.722	26.9	20.95	36.19	56.788	6.582	10.689	5.605	5.111
Mgc	1.683	1.856	1.068	0.835	2.351	1.864	2.131	2.716	1.698	2.51	1.931	2.186	1.713	1.097
Kc	0.79	0.256	0.375	0.259	1.002	0.412	0.698	1.476	1.266	1.804	1.515	1.079	0.206	0.156
pF 15 atm	15.322	8.613	8.203	7.366	19.117	13.001	11.975	14.24	13.197	20.783	21.82	25.704	11.82	6.673
Tx arc	17.758	19.78	14.503	17.28	40.015	25.394	19.763	24.24	21.293	24.894	28.13	38.122	25.83	13.59
Tx ar	20.448	62.411	54.254	64.238	19.986	45.694	55.826	37.85	46.001	46.244	35.95	29.844	44.98	64.93
Tx lim	61.794	17.803	31.245	18.51	40	28.906	24.413	37.94	32.712	28.863	35.93	32.033	29.2	21.49
CE	0.355	0.209	0.122	0.211	0.286	0.162	0.193	0.491	0.565	0.17	0.104	0.118	0.105	0.049
pH	8.275	7.43	7.475	6.616	8.085	7.633	7.77	7.943	7.776	8.044	8.225	8.021	7.581	6.13

CIC = cation exchange capacity in meq/100g; MOO = oxidable organic matter in %; Nt = total nitrogen in %; Pa = assimilable phosphorus in ppm; Mgc = exchangeable magnesium in meq/100g; Kc = exchangeable potassium in meq/100g; pF 15 atm = pressure at 15 atm (water retention capacity) in %; Tx arc = clayey texture in %; Tx ar = sandy texture in %; Tx lim = silty texture in %; EC = conductivity mmhos/cm; pH. 1AcH.-*Anacyclo clavati-Hordeetum leporini* Cano-Ortiz *et al*. 2009. 2ArH.-*Anacyclo radiati-Hordeetum leporinii* O. Bolòs & Rivas-Martínez in Rivas-Martínez 1978. 3BH.-*Bromo scoparii-Hordeetum leporinii* Rivas Martínez 1978. 4LR.-Co. *Linaria spartea et Raphanum raphanistrum*. 5PD.-*Papaveri rhoeadis-Diplotaxietum virgatae* Rivas Martínez 1978. 6ArP.-*Anacyclo radiati-Papaveretum rhoeadis* Cano-Ortiz *et al*. 2009. 7ArChr.-*Anacyclo radiati-Chrysanthemetum coronarii* (Rivas-Martínez 1978) Cano-Ortiz *et al*. 2009. 8RChr.-*Resedo albae-Chrysanthemetum coronarii* O. Bolòs & Molinier 1958. 9UM.-*Urtico urentis-Malvetum neglectae* (Knapp) Lohmeyer in Tüxen 1950. 10AB.-*Aveno barbatae-Brometum diandri* Baldoni & Biondi 1993. 11CA.-*Convolvulo elegantissimi-Aegilopetum geniculatae*. 12SD.-*Securigero securidacae-Dasypyretum villosii*. 13PA.-*Plantagini bellardii-Aegilopetum geniculatae* Cano-Ortiz, Pinto & Cano 2010. 14TT.-*Trifolio cherleri-Taeniatheretum capitis-medusae* Rivas-Martínez & Izco 1977.

minant species of each association, and will be essential for future studies on soil indicators. This work refers mainly to the description of new syntaxa.

In the PCA analysis (**Figure 4**) we have included 14 soil parameters and 86 samples, 45 of which correspond to the communities AB, CA and SD, plus 41 to the Iberian communities PA and TT. In the PCA correlation analysis, the Italian grasslands AB, CA and SD are grouped on one side and the Iberian grasslands are grouped on the other, thus highlighting the fact that although the CA community in Italy has a structure close to the communities of *Taeniatherum caput-medusae* (L.) Nevski and *Aegilops geniculata* Roth, its floristic composition and the substrate on which this community grows allows us to include it with the rest of the Italian communities rich in *Dasypyrum villosum* (L.) Borbas.

The first cluster analysis (**Figure 5**) performed to establish the similarity/dissimilarity between the different associations present in the western Mediterranean revealed two groups of associations very distant from each other: group G1 from 1 - 50 and group G2 from 11 to 47, with a distance of 100% between them. Of the 74 community tables, 42 (57.5%) have a distance of 75%, which highlights the substantial differences between the communities in the study.

Taking into consideration the dominant species in each community table, it can be seen in the cluster that the tables rich in *Hordeum leporinum* Link are distant from those which have a predominance of *Chrysanthemum coronarium* L. or *Dasypyrum villosum* (L.) Borbas. The tables rich in *Hordeum leporinum* Link are distributed with 15 in group G1 and 5 in G2; whereas all the tables with high indices of *Chrysanthemum coronarium* L. are grouped in G2. When the tables correspond to the same association—for example, 21 and 32—they have a high degree of similarity, with 94.12%. Both the communities with a high frequency of *Chrysanthemum coronarium* L. and those of *Dasypyrum villosum* (L.) Borbas have differences of over 75% with regard to those in which *Hordeum leporinum* Link is the dominant species. The floristic study shows clear differences between the 47 association tables from Spain, Portugal and northern Morocco, with 21 communities of 516 species, and the 27 tables from Italy with 22 communities of 448 species; this highlights a different floristic diversity in grasslands in the Iberian olive groves compared to Italian grasslands.

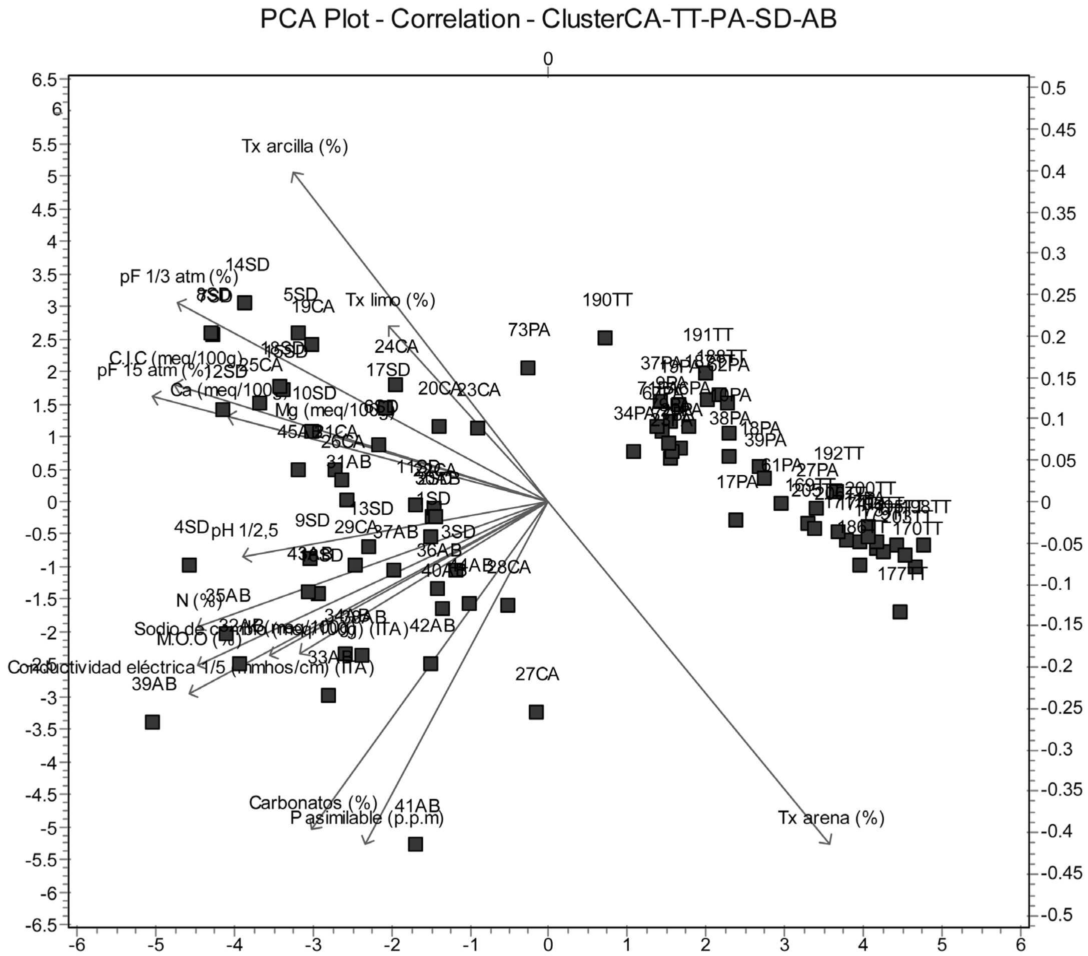

Figure 4. Soil correlation analysis for the associations in Italy (CA, SD, AB), Spain (TT) and Portugal (PA).

In view of the substantial soil differences in terms of organic matter, nitrogen, phosphorus and potassium, in addition to the floristic and structural differences, we propose for the centre-east of the Mediterranean territories the alliance *Securigero securidacae-Dasypyrion villosi* nova, an alliance with a Euro-Siberian and sub-Mediterranean optimum characterised by *Centaurea napifolia* L., *Crepis sancta* (L.) Babc., *Dasypyrum villosum* (L.) Borbas, *Bromus erectus* Huds., *Cerastium ligusticum* Viv., *Picris hieracioides* L., *Vulpia ligustica* (All.) Link. In this alliance we include the grassland communities from Euro-Siberian and sub-Mediterranean environments which present a high frequency of *Dasypyrum villosum* (L.) P. Candargy, which have until now been included in the alliance *Hordeion leporini* Br.-Bl. In Br.-Bl., Gajewski, Wraber & Walas 1936 corr. O. Bolòs 1962. We adopt as type of the new alliance the association *Bromo rigidi-Dasypiretum villosi* Pignatti 1953.

The communities dominated by *Chrysanthemum coronarium* L. or by *Hordeum leporinum* Link have significant structural, soil and floristic differences. At the soil level the communities of *Chrysanthemum coronarium* L. present soil parameter values of MO, Nt, P, K, and Mg which are closer to those of the communities of *Malvenion neglectae* Gutte 1966 than to those of *Hordeion leporinii* (**Table 2**); the frequent presence of species of *Malvenion neglectae* in the communities of *Chrysanthemum coronarium* L. and a vegetation structure of *Malvenion neglectae* [43], is sufficient reason to propose the new sub-alliance *Resedo albae-Chrysanthemenion coronarii* all nova which we subordinate to *Malvion neglectae* (Gutte 1966) status novo.

Separately we applied a Jaccard distance and RA ordination cluster analysis to the westernmost communities (Spain, Portugal and northern Morocco) (association tables 1 - 47) and to the Italian communities (48 - 74) in **Table 1**. Group EP1 appears in the first case, and includes the associations rich in *Chrysanthemum coronarium* L. and a group of associations EP2 dominated by *Hordeum leporinum* Link (**Figure 7**). In the RA analysis, all the tables of the different associations form a compact group C (tables 1 - 44) with the exception of tables 45, 46

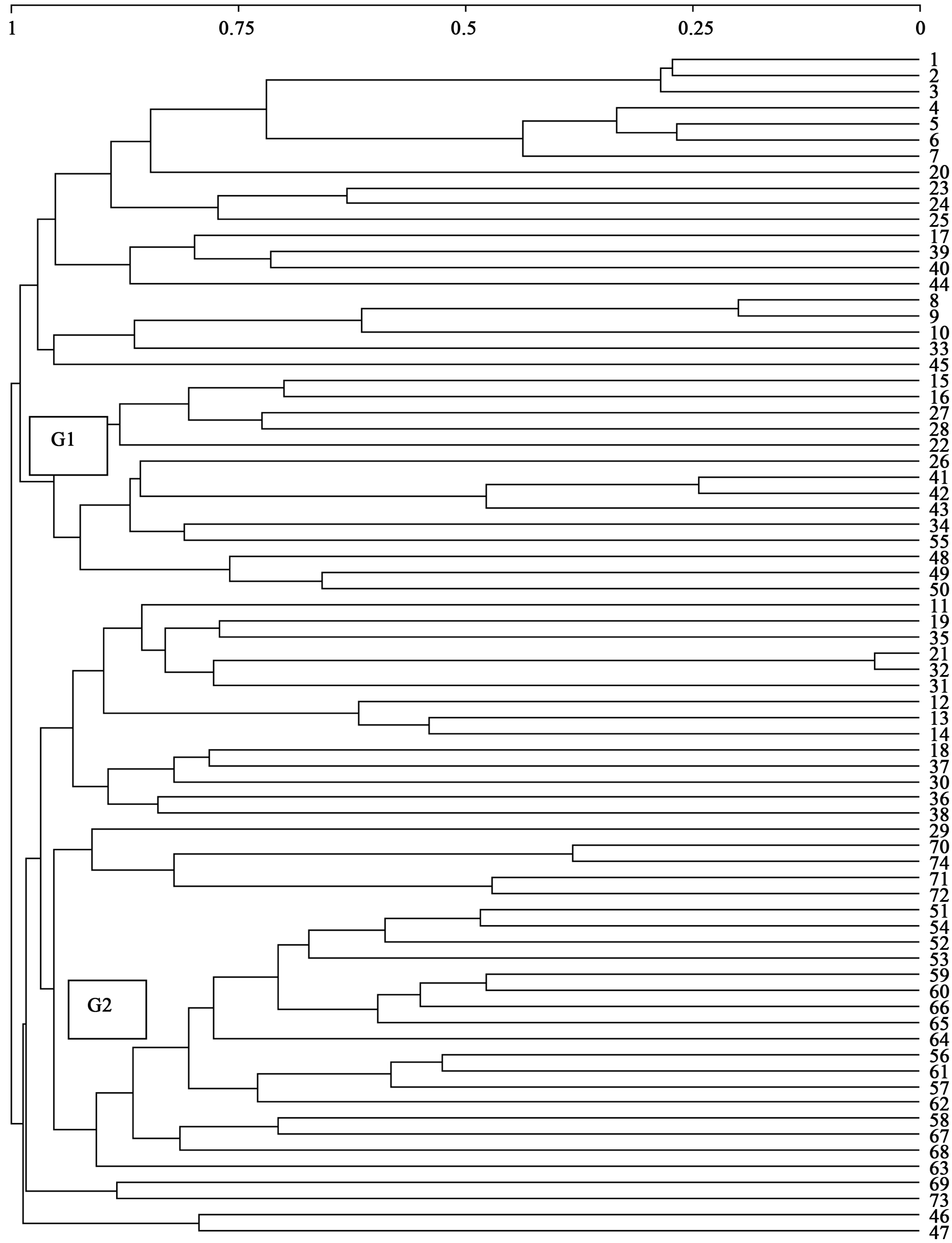

Figure 5. Clustering obtained from 740 rows (plants) × 74 association tables using Jaccard distance.

and 47 corresponding to the associations (45) *Schismo calycini-Malvetum trifidae* Br.-Bl., Font Quer, G. Br.-Bl., Frey, Jansen & Moor 1936, given by their authors [14] in Catalonia, whereas the associations (46) *Euphorbio terracinae-Anacycletum coronati* Reyes, Wildpret & León 2001 and (47) *Bromo-Hirschfeldietum incanae* Oberdorfer ex Lohmeyer 1975 have been given in Lanzarote by [31]; this last association was also given in Tenerife by [16], and is near the compact group of associations. Associations 19 and 47 given in Tenerife and Lanzarote presented a distance of 87.14%, with very little similarity between them; both tables do not therefore correspond to the same association, and have major floristic and biogeographical differences. Table 19, with seven inventories given in Tenerife, is rich in *Hordeumn leporinum* Link and has four inventories without *Hirschfeldia incana* (L.) Lagr.-Foss.; there is no presence of *Hordeum leporinum* Link in the 47 given in Lanzarote which present as differentials from the previous *Hordeum murinum* L. *subsp. glaucum* (Steud.) Tzvelev, *Erodium neuradifolium* Delile, *Avena fatua* L. *subsp. meridionales* A. W. Hill, *Avena sterilis* L. *subsp. ludoviciana* (Durieu) Guillet & Magne and the endemic species *Sonchus bourgeaui* Sch. Bip. In Webb & Berthel (**Figure 6** and **Figure 7**). W therefore propose a new association for Lanzarote: *Soncho bourgeaui-Hirschfeldietum incanae* Reyes *et al.* ex Cano nova, and we propose as type the synthetic inventory in Table 10 published by [31].

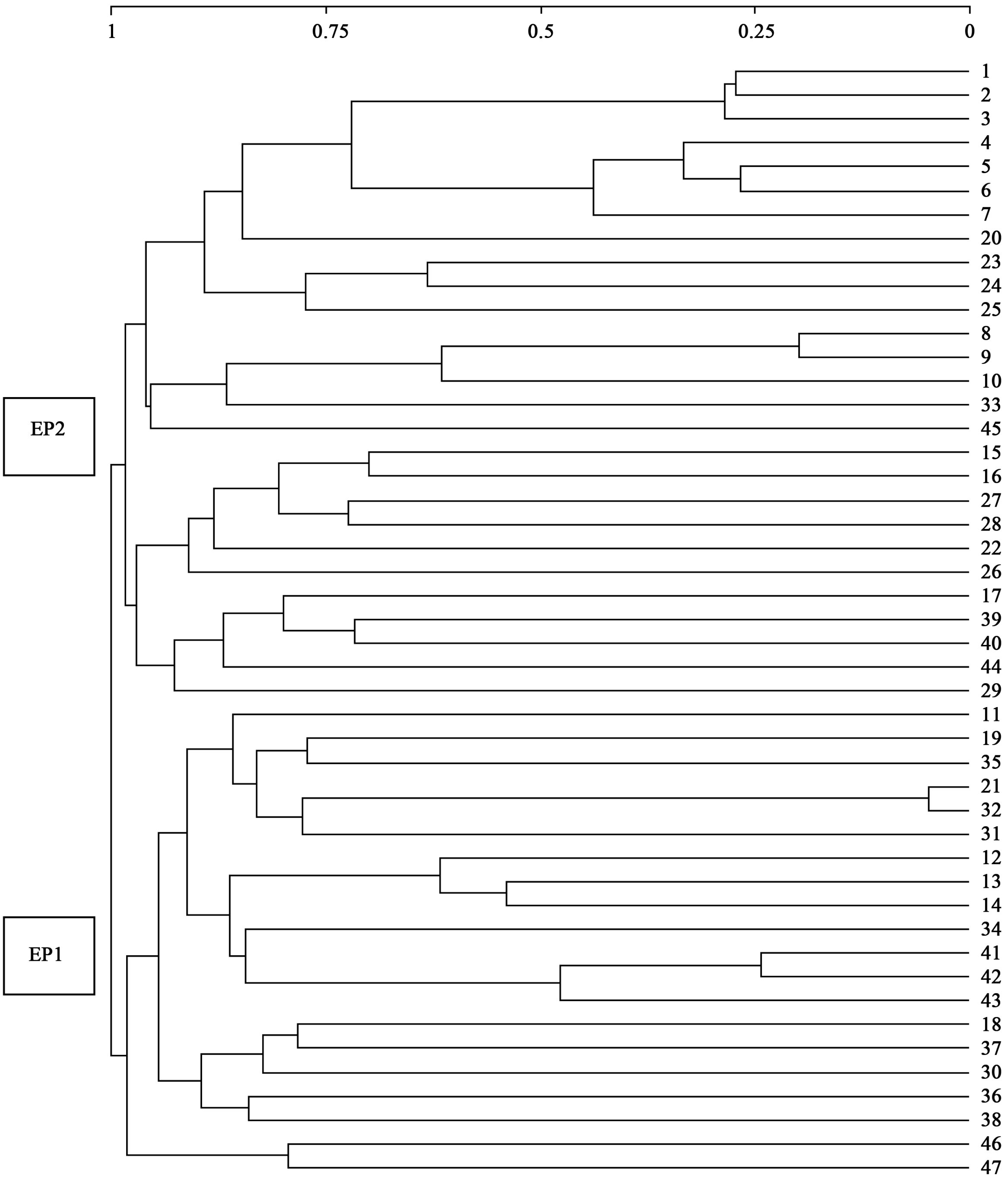

Figure 6. Jaccard distance clustering (Spain-N Morocco-Portugal).

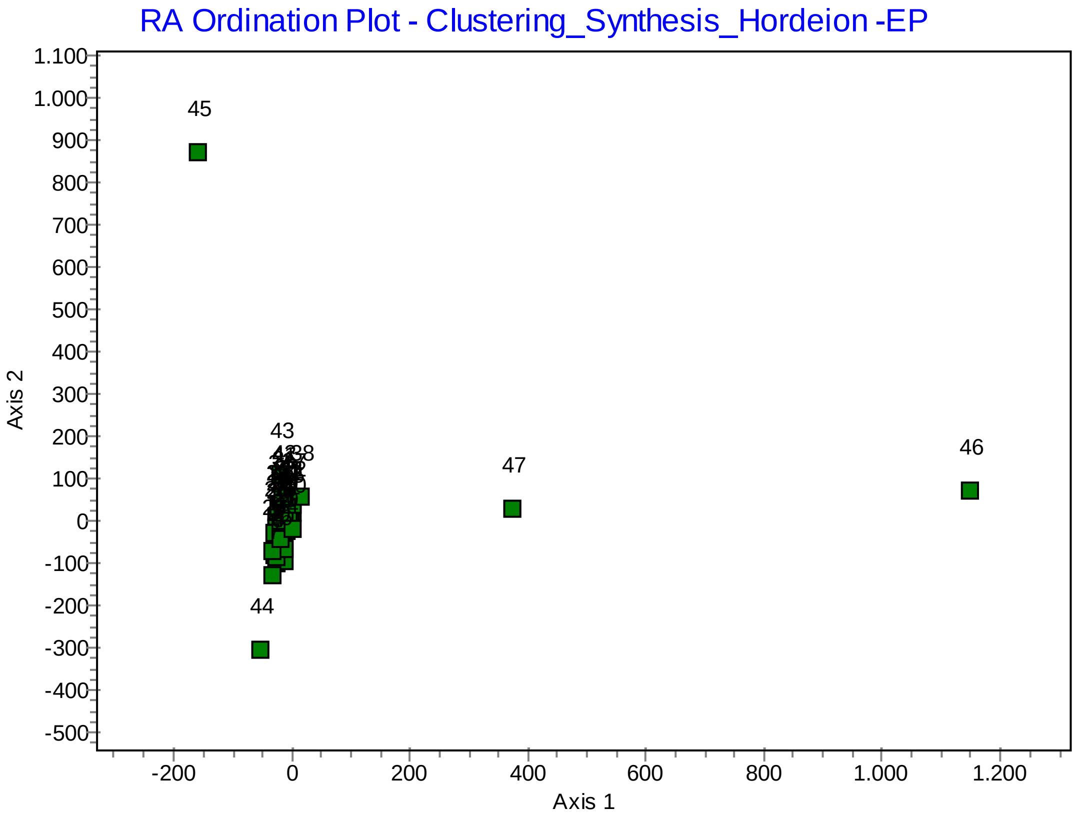

Figure 7. RA ordination analysis applied to the communities present in Spain, Portugal and northern Morocco.

In the case of Italy we applied the same statistical analysis as in the previous case. The cluster separates the tables of the associations belonging to the new alliance *Securigero securidacae-Dasypyrion villosi*, group M1 (association tables 48 - 74), from group M2 (51 - 63) (**Figure 8**) belonging to *Hordeion leporini* and to the new sub-alliance *Resedo albae-Chrysanthemenion coronarii*, with distances between both groups greater than 75%. On applying the DECORANA ordination analysis, the two groups M1 and M2 are separated. Group M1 includes the association tables 48 AB, 49 CA, 50 SD, 55 DA, 70 BD, 74 BD, 71 VD, 72 LD, 73 AB and 69 RP, but with a subgroup $M1_1$ formed by the communities inventoried by us (AB, CA, SD) (**Figure 9**).

The following cluster (**Figure 10**) based on the Excel chart with 281 rows (species) × 108 columns (inventories), differentiates various groups. Group G_1 (1SD-13oLD) includes 16 of the 18 samples of the association *Securigero securidacae-Dasypyretum villosii* (1SD-16SD); the two remaining samples (2SD-3SD) are separated from the rest as they have a greater quantity of *Hordeum leporinum* Link than of *Dasypyrum villosum* (L.) Borba. Also belonging to group G_1 are the inventories of the associations *Vulpio ligusticae-Dasypyretum villosi* (VD) and *Laguro ovati-Dasypyretum villosi* (LD), described by [36], which are together both in the cluster and in the DECORANA ordination analysis. The 11 inventories of *Convolvulo elegantissimi-Aegilopetum geniculatae* (CA) constitute a very clearly delimited group G_2 (19CA-20CA). The following 20 G_3 samples (1oBDv-18oDBv) belong to the association *Bromo rigidi-Dasypyretum villosi* Pignatti 1953, described for the north-eastern plain of Venice (Italy). The association *Aveno barbatae-Brometum diandri* belongs to group G_4 and comprises two subgroups: (30AB-43AB), which contains the 16 samples taken by us in grasslands in cultivated olive groves near Spoleto, Trevi, Foligno, Assisi (region of Umbria, Italy). The subgroup (1oAB-12oAB) includes the original samples published by [39]. Finally, a separate group G_5 (1oDA-4oDA) contains the inventories corresponding to the association *Dasypyro-Aegilopetum triuncialis* described by [32] in the Aspromonte.

The DECORANA ordination analysis (**Figure 11**) gives a first group of inventories (A) which belong to the original associations oAB, oBDv and the inventories taken by us belonging to AB; and a second group (B) constituted by the associations VD and LD described by [36], [38], which are perfectly separated from the SD and CA communities included in group (C).

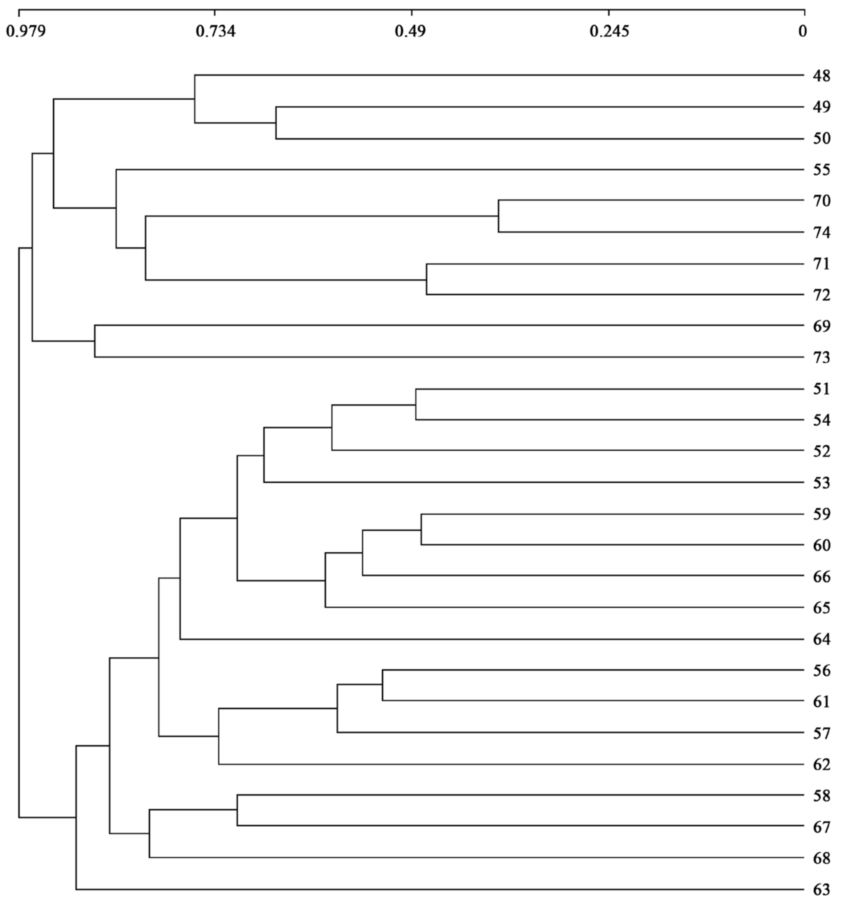

Figure 8. Jaccard distance clustering: Italian communities.

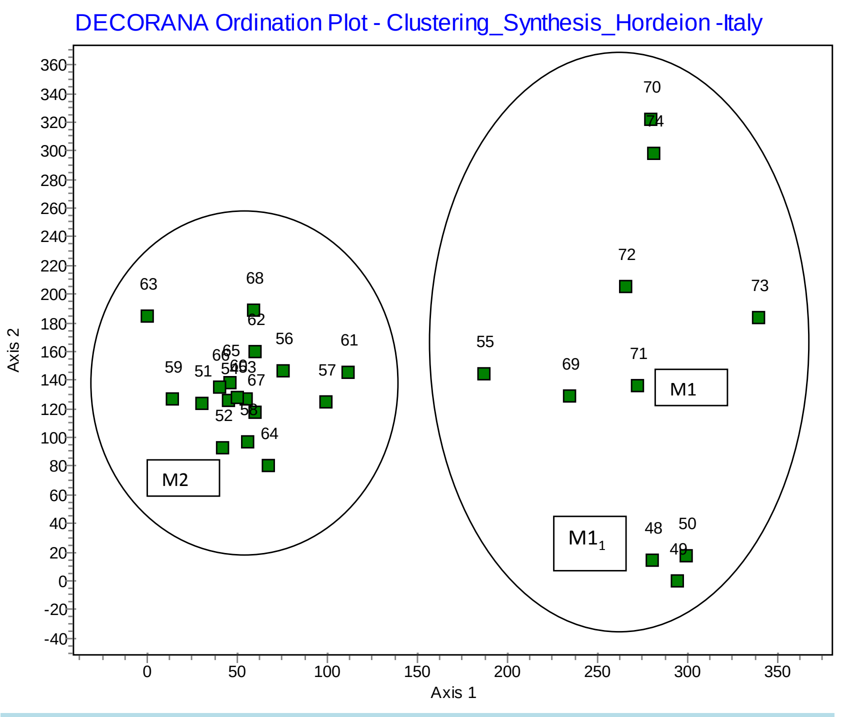

Figure 9. DECORANA ordination analysis: Italian communities.

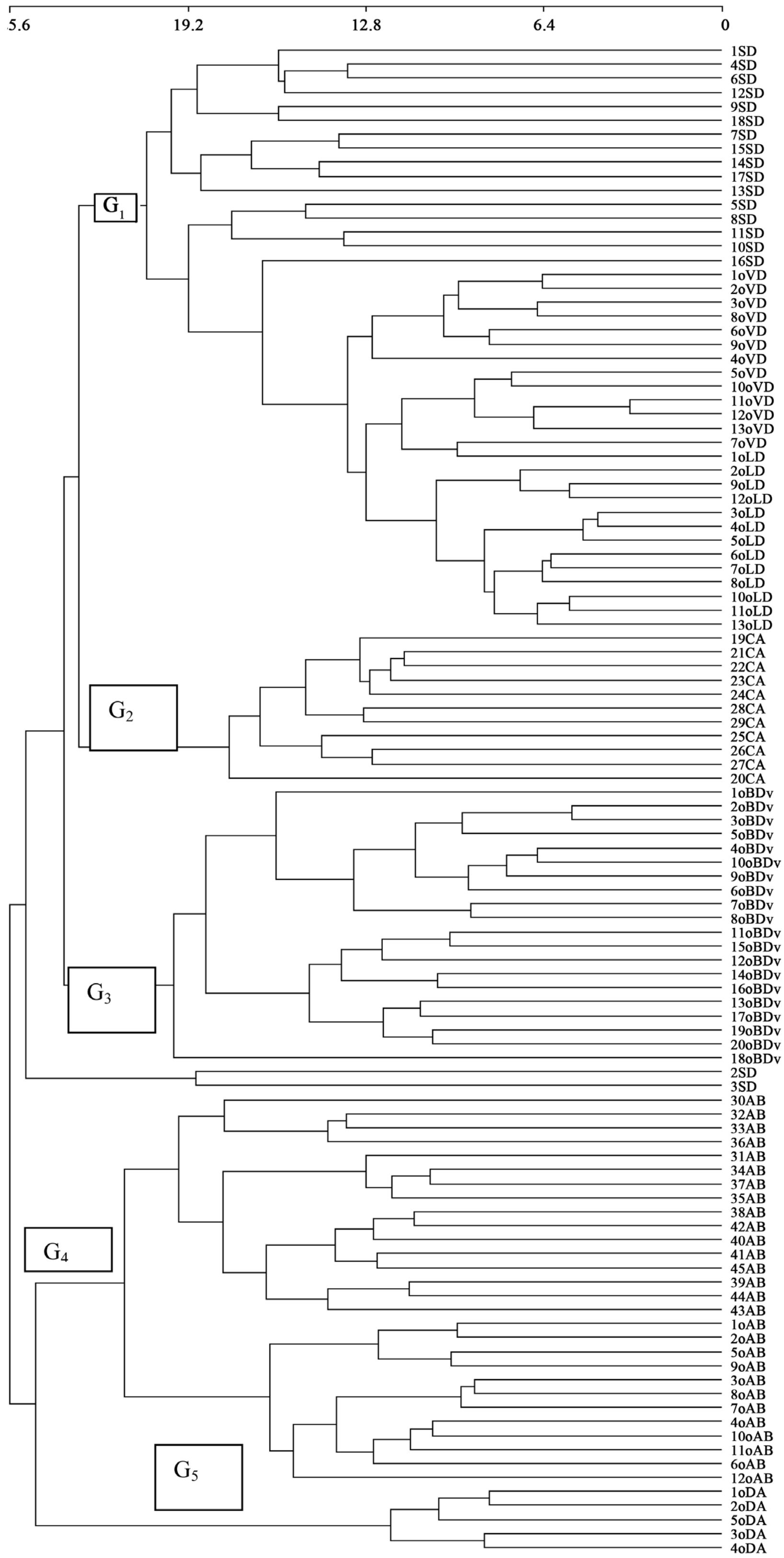

Figure 10. Euclidean distance cluster analysis for the Italian communities with *Dasypyrm villosum*.

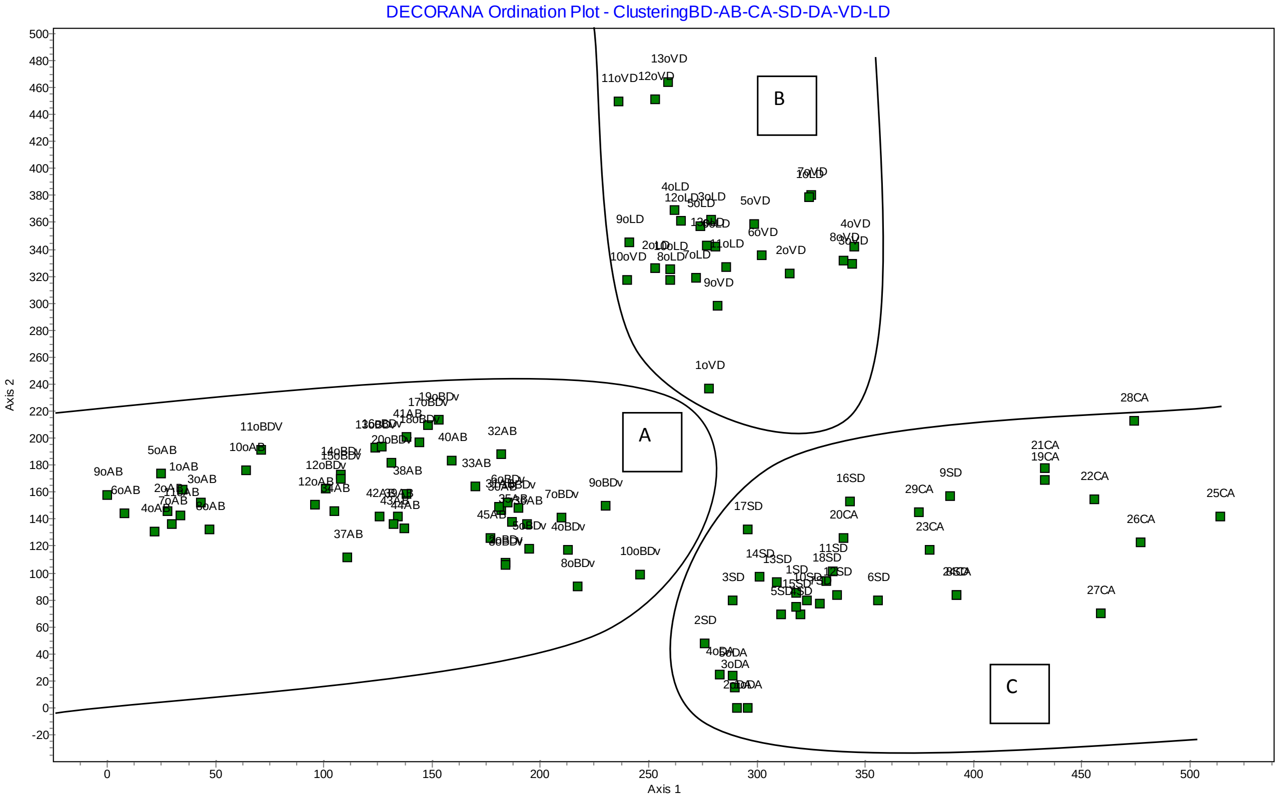

Figure 11. DECORANA ordination analysis for the Italian communities with *Dasypyrm villosum*.

The formation of two groups of Italian (I_1) and Iberian (I_2) communities (TT and PA) due to their soil differences, is corroborated by an analysis of conglomerates (**Figure 12**). The similarly between the CA communities in Italy and PA in Portugal and TT in Spain with regard to their physiognomy and plant structure does not justify their inclusion in the alliance *Taeniathero-Aegilopion geniculatae*; we thus maintain the CA communities within the new alliance *Securigero securidacae-Dasypirion villosi*.

As a result of the strong soil, floristic and biogeographical differences, we segregate from the alliance *Hordeion leporini* the communities rich in *Dasypyrum villosum* (L.) Borbas, which we include in the new alliance *Securigero securidacae-Dasypirion villosi*.

The alliance *Hordeion leporini* Br.-Bl. in Br.-Bl., Gajewski, Wraber et Walas 1936 corr. O. Bolòs 1962, includes grasslands growing in spring with a sub-nitrophilous and nitrophilous character. This alliance has its optimum in the Mediterranean and radiates to sub-Mediterranean territories. The species *Dasypyrum villosum* (L.) Borbas grows in the Gargano region in Italy, and is a calcicolous plant from southeast Europe which is absent from Spain and Portugal. A similar situation occurs with *Securigera securidaca* (L.) Deg. et Dorfl., which is distributed around southern Europe as far as southeast France. *Crepis sancta* (L.) Babc. appears frequently in the territories sampled in Italy, and is found in south-eastern Europe and the eastern Mediterranean region. This species is common in the region of La Marche, where it has been used to diagnose the vegetation infesting vineyards [40]. All the communities of *Dasypyrum villosum* (L.) Borbas are grassland formations with dense coverage and substantial biomass which flourish in environments with a high quantity of organic matter and nitrogen, with a pH always above 8.

As a consequence of the considerable soil, floristic and biogeographical differences, we segregate from the alliance *Hordeion leporine* the communities rich in *Dasypyrum villosum* (L.) Borbas which we include in the new alliance *Securigero securidacae-Dasypirion villosi*. These are nitrophilous grasslands with a sub-Mediterranean, thermo, meso, supra-Mediterranean and Euro-Siberian (central-European) thermo, meso and sub-temperate character, whose characteristic species are *Dasypyrum villosum* (L.) Borbas, *Securigera securidaca* (L.) Deg. et Dorfl., *Crepis sancta* (L.) Babc. As type association we propose *Bromo rigidi-Dasypiretum villosi* Pignatti 1953.

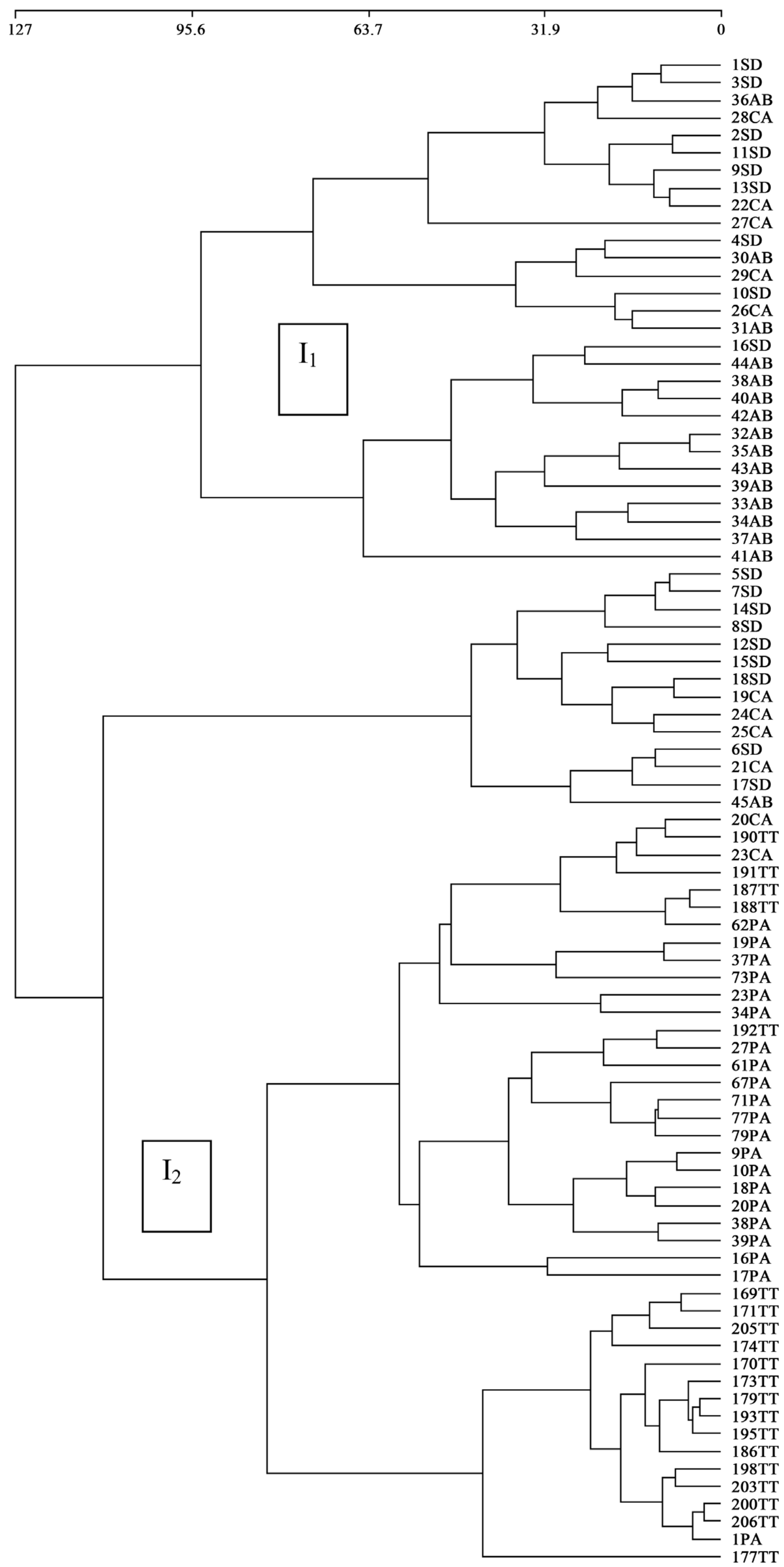

Figure 12. Cluster analysis among associations for Italy, Spain and Portugal.

The three types of grasslands studied in Italy belong to three different communities AB, CA, SD, and are perfectly separated in the cluster and in the PCA (Figure 13 and Figure 14), with the exception of samples 2 and 3 in SD which are separated in the cluster but not in the PCA, due to their greater richness in alliance plants.

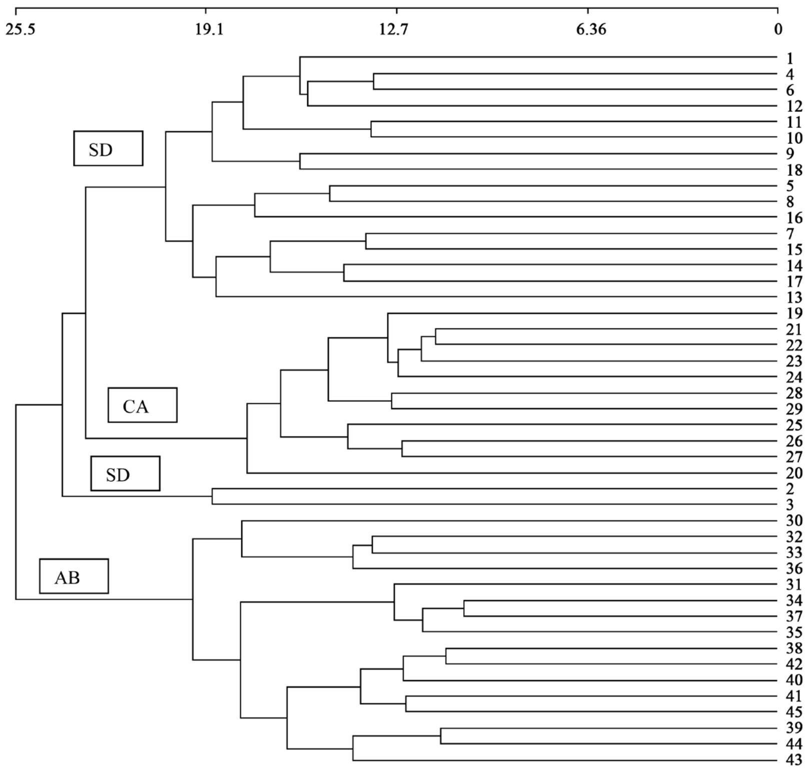

Figure 13. Cluster analysis for the three associations studied in Italy.

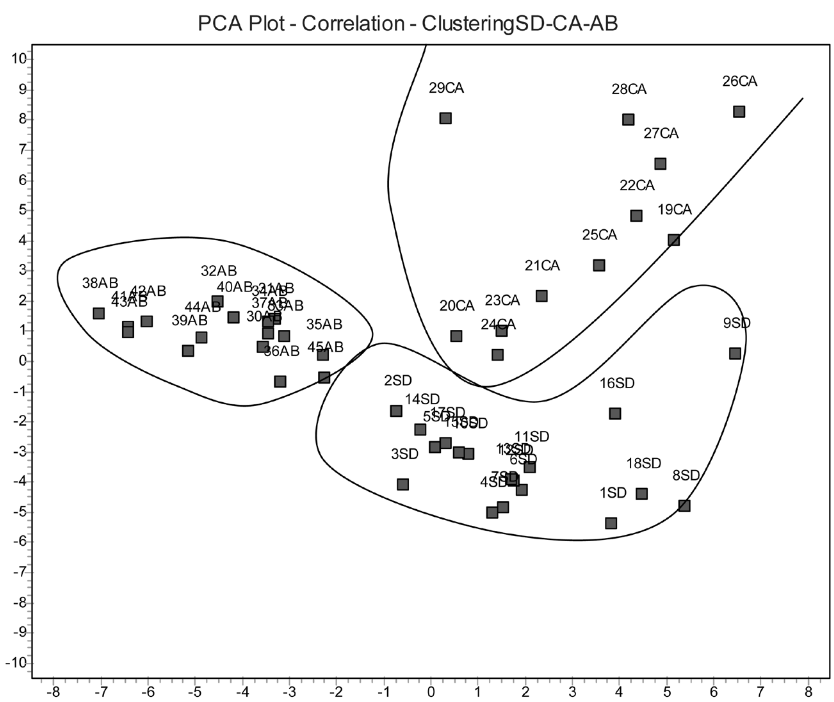

Figure 14. PCA for the three associations studied in Italy.

Aveno barbatae-Brometum diandri Biondi & Baldoni 1991 has been published by its authors for central Italy [39], initially located in the regions of Tuscany, Marche, Umbria and Lazio. The sampled community is a grassland with a ruderal character growing on disturbed soils, with therophytic vegetation whose successive evolution leads to perennial herbaceous formations of hemicryptophytes, belonging to the class *Agropyretea intermedii-repentis* Muller et Görs 1969 and the alliance *Convolvulo-Agropyrion repentis* Görs 1967—a syntaxon which indicates good soil humidity—whereas in drier areas it contacts with the class *Festuco-Brometea* Br.-Bl. et Tx. 1943, association *Centauro bracteatae-Brometum erecti* Biondi *et al.* 1986. Its soil character indicates that it is located on terrains with pH values of 8.04; C.E.C (meq/100g) 24.685; OOM (%) 6.389; P (p.p.m) 59.04; sandy-silty texture, average CR. This association is dominated by species such as *Bromus Diandrus* Roth, *Bromus madritensis* L., *Avena barbata* Pott ex Link, *Hordeum leporinum* Link.

The association *Convolvulo elegantissimi-Aegilopetum geniculatae* Cano-Ortiz, Biondi & Cano nova hoc loco (**Table 3** inv. 1-11 typus inv. 8) was inventoried by us in the region of Gargano, a territory located in southeast Italy on the coast of the Adriatic. Precipitation ranges between 686 mm and 1.082 mm, and average annual Tª is between 11.0˚C - 15.3˚C [41]. The dominant materials are basic, with frequent appearance of decarbonated substrates with a neutral-basic character. The association we propose is characterised floristically by *Aegilops geniculata* Roth and the endemism *Convolvulus elegantissimus* Miller. This is a grassland which appears relatively frequently in abandoned olive groves, where the organic matter is somewhat inferior to the rest of the nearby communities (**Table 2**) such as *Aveno barbatae-Brometum diandri* Biondi et Baldoni 1991 and *Securigero securidacae-Dasypyretum villosii*; however the average annual Tª is higher, and the thermotype is meso- and thermo-Mediterranean with a dry-subhumid ombrotype. The distribution area for this new syntaxon is at least the Gargano. Due to the soil values obtained, its floristic composition and its structure, we include this association *Convolvulo elegantissimi-Aegilopetum geniculatae* in the new alliance *Securigero securidacae-Dasypyrion villosii*. The new association is included in the series *Cyclamidi hederifolii-Querco ilicis* s., *Cyclamidi hederifolii-Querco Virginianae* s., *Fraxino orni-Querco ilicis* s. [41].

Finally the association *Seurigero securidacae-Dasypyretum villosii* Cano-Ortiz, Biondi & Cano nova hoc loco (**Table 4** inv. 1-18 typus inv. 13); this community was inventoried in the region of Gargano, and grows in meso-Mediterranean subhumid environments on basic substrates. It is dominated floristically by *Dasypyrum villosum* (L.) Borba, *Securigera securidaca* (L.) Deg. et Dorfl., *Echium italicum* L., *Medicago tenoreana* Ser., *Medicago disciformis* DC., *Medicago intertexta* (L.) Miller, *Bromus ramosus* Hudson.

This is a community which grows on soils with a higher content of MOO and nitrogen than *Convolvulo elegantissimi-Aegilopetum geniculatae*, and we include it in the alliance *Securigero securidacae-Dasypyrion villosii*. This new association *Securigero securidacae-Dasypiretum villosii* (50SD) is statistically separate from the *Avenulo barbatae-Brometum diandri* Biondi et Baldoni 1991 (48AB), (**Figure 9**) described for central Italy and which is characterised by *Bromus diandrus* Roth, *Avena barbata* Potter, *Hordeum leporinum* Link, *Crepis vesicaria* L. *subsp. taraxacifolia* [39]. It is additionally differentiated from the association *Bromo rigidi-Dasypyretum villosi* Pignatti 1953, also described for the eastern Venetian plain, which is characterised by a dominance of *Dasypyrum villosum* and *Bromus rigidus* (L.) Hubbard.

The high frequency of *Securigera securidaca* (L.) Deg. et Dorfl. in our association, absent in the previous associations, in addition to the bioclimatic and biogeographical differences, are sufficient reason to propose this new association with a sub-Mediterranean character and with a distribution areas which is at least the Gargano region.

4. Conclusions

This study clearly highlights the differentiation of Italian grasslands from Iberian grasslands, which are separated into two alliances: the alliance *Hordeion leporini* distributed throughout the western Mediterranean, from which we segregate the communities of *Chrysanthemum coronarium* L., as they present soil, floristic and structural differences which will be included in the new sub-alliance *Resedo-Crhysanthemenion coronarii*. The analysis of 74 association tables containing 847 inventories and the study of 16 soil parameters in each of the 265 samples provides sufficient information to propose the new alliance *Securigero securidacae-Dasypyrion villosi*, nitrophilous grasslands with a sub-Mediterranean, thermo, meso, supra-Mediterranean and Euro-Siberian (central-European) thermo, meso and sub-temperate character, whose characteristic species are *Dasypyrum villosum* (L.) Borba, *Securigera securidaca* (L.) Deg. et Dorfl., *Crepis sancta* (L.) Babc. As type association we

Table 3. *As. Convolvulo elegantissimi-Aegilopetum geniculatae* Cano-Ortiz, Biondi & Cano nova hoc loco.

Order number	1	2	3	4	5	6	7	8	9	10	11	P
Number of field inventory	19	20	21	22	23	24	25	26	27	28	29	R
Slope %	0	0	0	0	0	0	7	5	0	0	0	E
Orientation	-	-	-	-	-	-	S	SE	-	-	-	S
Coverage %	100	100	80	90	60	80	80	100	60	90	90	E
Área m^2	1	1	1	1	1	1	1	1	1	1	1	N
Altitude in m	49	68	44	33	31	21	38	255	98	186	312	C
Average height of dominant vegetation in m	0.300	0.400	0.300	0.250	0.250	0.250	0.300	0.250	0.200	0.250	0.250	E
Average height of dominant vegetation in m	0.400	0.500	0.400	0.350	0.300	0.350	0.400	0.350	0.250	0.350	0.350	S
Association characteristics and higher units												
Aegilops geniculata Roth	5	5	4	4	3	4	4	5	3	4	4	V
Dasypyrum villosum (L.) Borbas	1	2	+	1	+	1		+		+	1	IV
Avena fatua L.	+	+		+	+	1		+	1			III
Scorpiurus muricatus L.	+	1	1	1		+	1					III
Plantago lagopus L.	2		1	+	+			1			1	III
Medicago disciformis DC.		3		1	1		+	2	1			III
Leontodon taraxacoides (Vill.) Merat				+		1	+	+	+	+		III
Trifolium campestre Schreber	1	3			+	1		+				II
Satureja cuneifolia Ten.				1			+	+	+	+		II
Anagallis coerulea Schreber		+			+		+	1	+			II
Urospermum picroides (L.) Schmidt			+		+				+	+		II
Urospermum dalechampii (L.) Schmidt			+	+						+	+	II
Scabiosa maritima L.	1			+				+		+		II
Reichardia picroides (L.) Roth	+		+	+			+					II
Ononis ornithopodioides L.	+			+				+	+			II
Medicago arabica (L.) Hudson	+			+	1						1	II
Euphorbia peplus L.	+					+		+			1	II
Convolvulus elegantissimus Miller				+			1	1		+		II
Bromus ramosus Hudson		+	+		+	1						II
Stipa capensis Thunb.									+	1	1	I
Onobrychis aequidentata (S. et S.) D'Urv.							3	+	1			I
Muscari comosum (L.) Miller	+							+		+		I
Linum strictum L.									1	1	+	I
Hordeum leporinum Link		2				+					+	I
Galactites tomentosa Moench	+		+			+						I
Trifolium stellatum L.								1	+			I
Tordylium apulum L.									+		+	I
Securigera securidaca (L.) Deg. et Dorfl.	+		1									I
Picris hieracioides L.					+	1						I

Continued

Onobrychis caput-galli (L.) Lam.								2	2			I
Lotus ornithopodioides L.			+							1		I
Lotus creticus L.				+						+		I
Linum bienne Miller				+	+							I
Cynosurus echinatus L.								+	+			I
Catapodium rigidum (L.) Hubbard						+					+	I
Briza maxima L.					+				+			I
Vicia lutea L.						+						1
Vicia bithynica (L.) L.										1		1
Trifolium scabrum L.									+			1
Trifolium resupinatum L.			+									1
Trifolium dubium Sibth.								+				1
Trifolium bocconei Savi								1				1
Trifolium arvense L.	+											1
Torilis nodosa (L.) Gaertner					+							1
Sonchus asper (L.) Hill			+									1
Silene conica L.											+	1
Sherardia arvensis L.											+	1
Scandix pecten-veneris L.									+			1
Reseda alba L.								+				1
Plantago afra L.										+		1
Ononis reclinata L.										+		1
Mercurialis ambigua L. fil.									1			1
Medicago orbicularis (L.) Bartal.		1										1
Medicago murex Willd.		1										1
Lolium temulentum L.		2										1
Lathyrus ochrus (L.) DC.					+							1
Lagurus ovatus L.											1	1
Hedysarum coronarium L.											+	1
Hedypnois cretica (L.) Willd.									+			1
Galium lucidum All.			+									1
Euphorbia exigua L.											+	1
Daucus carota L.				+								1
Crepis vesicaria L.											+	1
Crepis capillaris (L.) Wallr.					+							1
Coronilla scorpioides (L.) Koch									+			1
Chrysanthemum segetum L.						+						1
Chamaemelum mixtum (L.) All.											1	1

Continued

Centaurium erythraea Rafn				+								1
Centaurea deusta Ten.										+		1
Biscutella didyma L.								+				1
Bellardia trixago (L.) All.	+											1
Anthyllis tetraphylla L.							+					1
Anthemis tinctoria L.					+							1
Companion species												
Dactylis glomerata L.	+	+	1		+		+	+				II
Tragopogon porrifolius ssp. australis sensu Richarson			+						+	+		I
Sanguisorba minor Scop.	+			+			+					I
Psoralea bituminosa L.			+	+			2					I
Polygala monspeliaca L.								+		+	+	I
Pallenis spinosa (L.) Cass.	+				1					1		I
Serapias parviflora Parl.	+						+					I
Hippocrepis unisiliquosa L.	2							+				I
Cynodon dactylon (L.) Pers.										1	1	I
Brachypodium distachyum (L.) Beauv.	1					2						I
Allium roseum L.				+				+				I
Trifolium subterraneum L.					1							I
Serapias vomeracea (Burm.) Briq.	+											I
Poa bulbosa L.											+	I
Plantago serraria L.			1									I
Hypericum perforatum L.				+								I
Helianthemum salicifolium (L.) Miller									+			I
Gladiolus italicus Miller	+											I
Crupina crupinastrum (Moris) Vis.									+			I
Cirsium arvense (L.) Scop.						+						I
Cerastium glomeratum Thuill.											+	I
Cephalaria leucantha (L.) Schrader & Schult											+	I
Carduus pycnocephalus L.		+										I
Astragalus sesameus L.										+		I
Anthyllis vulneraria L.								1				I
Allium subhirsutum L.							+					I

Sites: All the inventories were taken in the region of Apulia (Gargano), Italy.

Number inventory	1	2	3	4	5	6	7	8	9	10	11
Coordinata X (m)	2,604,242	2,612,533	2,613,213	2,613,482	2,614,885	2,615,399	2,618,141	2,617,148	2,614,802	2,610,874	2,606,277
Coordinata Y (m)	4,641,580	4,638,281	4,637,520	4,637,494	4,637,275	4,637,323	4,632,400	4,627,869	4,622,944	4,619,398	4,616,095

Table 4. *As. Securigero securidacae-Dasypyretum villosii* Cano-Ortiz, Biondi & Cano nova hoc loco.

Order number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	P
Number of field inventory	**1**	**2**	**3**	**4**	**5**	**6**	**12**	**11**	**7**	**8**	**9**	**10**	**15**	**13**	**14**	**16**	**17**	**18**	R
Slope %	4	3	2	0	0	0	0	3	8	9	10	2	2	3	0	0	0	0	E
Orientation	SE	SE	NE	-	-	-	-	N	NE	SE	SW	NE	SE	N	-	SW	-	-	S
Coverage %	100	90	100	100	100	100	100	60	90	100	70	70	100	100	100	90	70	90	E
Área m^2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	N
Altitude in m	324	289	258	182	110	72	130	169	117	227	317	194	286	141	269	245	92	52	C
Average height of dominant vegetation in m	0.8	0.4	0.6	0.6	0.8	0.6	0.6	0.35	0.9	0.7	0.35	0.45	0.45	0.5	0.45	0.5	0.5	0.8	E
Average height of dominant vegetation in m	0.8	0.6	0.5	0.9	1	1	1	0.8	0.5	1.2	0.5	0.7	0.9	1	0.8	1	1	0.9	S
Association characteristics and higher units																			
Dasypyrum villosum (L.) Borbas	4		2	5	5	5	5	3	4	5	3	3	5	5	5	4	3	4	V
Securigera securidaca (L.) Deg. et Dorfl.	+	1		1	2	2	+	1	1	2	1		2	+		1	1		IV
Leontodon taraxacoides (Vill.) Merat	2	1	2	2		2		2	+	2	1	2	+	1					III
Bromus ramosus Hudson	5	1	2	3		2	5				1	1	+		1		1	2	III
Briza maxima L.	1	+		+		1	1	1	1	1	1			1				1	III
Sherardia arvensis L.	1				2		1	1	1		+	1	1				+	1	III
Avena fatua L.	2		1		1	+	+			2			+			+	+	+	III
Vicia lutea L.	+	+		+	+	+	1						2	1			+		III
Nigella damascena L.						+	+	+	1	1			+	1		1	1		III
Sonchus asper (L.) Hill	+	+		+				+						1		+		+	II
Medicago intertexta (L.) Miller			2	1		+	+		1				2		2				II
Erodium malacoides (L.) L'HÚr.	1	2	2	1		+									1		+		II
Anagallis coerulea Schreber	+	+		1		+			+		+						+		II
Urospermum picroides (L.) Schmidt			+					+	+				1	1	+				II
Trifolium stellatum L.			+	+							3	2	2					2	II
Medicago orbicularis (L.) Bartal.		2	1	1					2				2				1		II
Lotus ornithopodioides L.		1		+				+							+	1	+		II
Galactites tomentosa Moench							+	2	+			2		1				+	II
Hordeum leporinum Link		3	5											3	2		2		I
Geranium molle L.		2		1								+		+		+			I
Euphorbia peplus L.				1					+						+	+	+		I
Vicia bithynica (L.) L.					1	+	1										+		I
Reichardia picroides (L.) Roth	+										+					+		1	I
Picris hieracioides L.	+						1									1	+		I
Medicago sativa L.	+	3	2	2															I
Medicago murex Willd.			2		+							1						1	I
Convolvulus arvensis L.				+			+	+					+						I
Bunias erucago L.			1				+								1		2		I
Borago officinalis L.					+				+						+		+		I

Continued

Torilis nodosa (L.) Gaertner										1		+		+					I
Stachys germanica L.	1										+							+	I
Sinapis arvensis L.	+							+						+					I
Rhagadiolus stellatus (L.) Willd.	2								+					1					I
Mercurialis annua L.	+									+						+			I
Medicago minima (L.) Bartal.								+		1	1								I
Lolium temulentum L.				1										1			+		I
Leontodon cichoraceus (Ten.) Sanguin.			+	+		+													I
Crepis pulchra L.				1										2				1	I
Calendula arvensis L.	2		+									+							I
Anthemis tinctoria L.		+									1					1			I
Valerianella divaricata Lange			1					1											I
Scabiosa maritima L.											+					+			I
Plantago lagopus L.														1				+	I
Plantago afra L.										+		+							I
Pallenis spinosa (L.) Cass.	+										+								I
Medicago tenoreana Ser.													1		2				I
Medicago disciformis DC.					+												2		I
Malva cretica Cav.									+	+									I
Lathyrus ochrus (L.) DC.					+								+						I
Hedypnois cretica (L.) Willd.												+						+	I
Euphorbia pinea L.											+					+			I
Cynosurus echinatus L.										+	1								I
Chamaemelum mixtum (L.) All.																	+	+	I
Bromus hordeaceus L.																	+	1	I
Vicia cracca L.													2						I
Veronica hederifolia L.									+										I
Veronica acinifolia L.			+																I
Trifolium angustifolium L.																		+	I
Torilis arvensis (Hudson) Link					+														I
Sinapis pubescens L.																1			I
Sinapis alba L.														+					I
Silene vulgaris (Moench) Garcke							+												I
Sideritis romana L.						1													I
Scorpiurus muricatus L.										+									I
Rumex acetosa L.							+												I
Reseda alba L.														+					I
Rapistrum rugosum (L.) All.										1									I
Ranunculus repens L.															2				I

Continued

Ornithogalum umbellatum L.																		+	I
Orlaya kochii Heyw.										1									I
Ononis ornithopodioides L.													+						I
Medicago truncatula Gaertner		4																	I
Medicago rugosa Desr.												1							I
Medicago rigidula (L.) All.												2							I
Medicago lupulina L.	1																		I
Medicago arabica (L.) Hudson														+					I
Lotus corniculatus L.											+								I
Lolium rigidum Gaudin																	+		I
Linaria vulgaris Miller																+			I
Lathyrus sphaericus Retz.						+													I
Lathyrus annuus L.									+										I
Lagurus ovatus L.			2																I
Geranium lucidum L.									+										I
Euphorbia helioscopia L.			+																I
Euphorbia exigua L.		1																	I
Echium vulgare L.																+			I
Echium italicum L.	+																		I
Daucus carota L.																+			I
Cynoglossum creticum Miller																		+	I
Crepis vesicaria L. *ssp. vesicaria*																		3	I
Coronilla scorpioides (L.) Koch								+											I
Cirsium arvense (L.) Scop.														+					I
Cichorium intybus L.																		+	I
Chrysanthemum segetum L.																	+		I
Cerinthe major L.					2														I
Centaurium erythraea Rafn											+								
Bellardia trixago (L.) All.								+											
Anthyllis tetraphylla L.										1									1
Aegilops geniculata Roth							2												1
Companion species																			
Carduus pycnocephalus L.	+		+	1	+	+	+	+		1		+	+	1	+		1		IV
Tordylium apulum L.	2	+		1				2			+	2	1	2				1	III
Theligonum cynocrambe L.		1		1	2	1	1	2		2		1							II
Arum italicum Miller				+	+		+		+			+							I
Rubus ulmifolius Schott				+		+			+	+									I
Geranium dissectum L.						+			1				1		+				I
Allium roseum L.	+					+		+						2					I

Continued

Psoralea bituminosa L.				+						+	1								I
Dactylis glomerata L.											+					+		+	I
Calamintha nepeta (L.) Savi																+	+	+	I
Brachypodium distachyum (L.) Beauv.								+				+				+			I
Serapias vomeracea (Burm.) Briq.											+							+	I
Sanguisorba minor Scop.	+						+												I
Poa infirma H.B.K.			1									1							I
Parietaria diffusa M. et K.				+												1			I
Allium subhirsutum L.						2										3			I
Vulpia myuros (L.) Gmelin											+								I
Urginea maritima (L.) Baker																		+	I
Trifolium subterraneum L.																		2	I
Trifolium repens L.				+															I
Trifolium pratense L.															1				I
Tragopogon porrifolius ssp. australis sensu Richarson											+								I
Serapias parviflora Parl.											+								I
Rubia peregrina L.																+			I
Myosotis arvensis (L.) Hill					+														I
Minuartia hybrida (Vill.) Schischkin			2																I
Melilotus sulcata Desf.										+									I
Melilotus segetalis (Brot.) Ser.								+											I
Gladiolus italicus Miller										+									I
Galium aparine L.					+														I
Foeniculum vulgare Miller *ssp. piperitum* (Ucria) Coutinho																	+		I
Dorycnium hirsutum (L.) Ser.									1										I
Cynodon dactylon (L.) Pers.																	+		I
Carlina corymbosa L.											+								I
Asparagus acutifolius L.														+					I

Sites: All the inventories were taken in the region of Apulia (Gargano), Italy.

Number inventory	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Coordinata X (m)	2,600,673	2,600,840	2,600,918	2,601,126	2,601,804	2,602,075	2,598,127	2,598,272	2,601,969	2,601,299	2,598,367	2,598,233	2,595,602	2,593,337	2,595,095	2,594,021	2,592,512	2,588,641
Coordinata Y (m)	4,639,902	4,640,096	4,640,389	4,641,231	4,641,371	4,640,553	4,641,885	4,641,756	4,639,929	4,638,697	4,640,528	4,641,531	4,640,478	4,641,509	4,640,617	4,639,611	4,639,439	4,638,046

propose *Bromo rigidi-Dasypyretum villosi* Pignatti 1953. In this alliance we include all the associations rich in *Dasypyrum villosum* (L.) Borbas and the two new associations inventoried by us: *Convolvulo elegantissimi-Aegilopetum geniculatae* and *Securigero securidacae-Dasypyretum villosii*. We propose the new sub-alliance *Resedo albae-Chrysanthemenion coronarii* subordinated to the alliance *Malvion neglectae*, in which we include all the associations rich in *Chrysanthemum coronarium* L. In order to arrive at these conclusions, it was necessary to take into consideration the value of soil factors as the cause of the abundance of the species, and to establish the values for the different soil parameters which act as soil nutrients for the different grassland communities. We therefore used the synthetic Braun-Blanquet index, adapting it for the first time to the Van der Maarel values; this gives considerable strength to the presence of the species in the community, making it possible to establish the distance between associations. We also propose the new association *Soncho bourgeaui-Hirschfeldietum incanae* Reyes *et al*. ex Cano nova, based on the table of [31].

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Hordeo-Centauretum macracanthae Brullo 1983
Malvion neglectae (Gutte 1966) status novo
Resedo albae-Chrysanthemenion coronarii Cano-Ortiz, Biondi & Cano suball. nova
Resedo albae-Chrysanthemetum coronarii O. Bolòs & Molinier 1958
Anacyclo radiati-Chrysanthemetum coronarii (Rivas-Martínez 1978) Cano-Ortiz, Pinto-Gomes, Esteban, Rodríguez-Torres, Goñi, De la Haza & Cano 2009
Malvo parviflorae-Chrysanthemetum coronarii Ferro 1980
Lavatero creticae-Chrysanthemetum coronarii Ferro 2004
Securigero securidacae-Dasypyrion villosi Cano-Ortiz, Biondi & Cano all. nova
Bromo rigidi-Dasypyretum villosi Pignati 1953
Securigero securidacae-Dasypyretum villosi Cano-Ortiz, Biondi & Cano nova hoc loco
Convolvulo elegantissimae-Aegilopetum geniculatae Cano-Ortiz, Biondi & Cano nova hoc loco
Aveno barbatae-Brometum diandri Baldoni & Biondi 1993
Dasypyro-Aegilopetum triuncialis Brullo, Scelsi & Spanpinato 2001
Laguro ovati-Dasypyretum villosi Falleni 1998
Vulpio ligusticae-Dasypyretum villosi Falleni 1998

Rumici-Carduetum pycnocephali Kruska 1985
Artemisietea vulgaris Lohmeyer, Preising & Tüxen ex von Rochow 1951
Carthametalia lanati Brullo in Brullo & Marcenò 1985
Silybo-Urticion Sissingh ex Br.-Bl. & O. Bolòs 1958
Chrysanthemo-Silybetum mariani Bullo 1983