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Alpine plant communities in the Picos de Europa calcareous massif (Northern Spain)

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Abstract: Jiménez-Alfaro, B., Alonso Felpete, J.I., Bueno Sánchez, A. & Fernández Prieto, J.A. *Alpine plant communities in the Picos de Europa calcareous massif (Northern Spain). Lazaroa 35: 67-105 (2014).*

Mountains of Southern Europe are important refuges for cold-adapted plants, and the characterization of vegetation diversity in these areas is a relevant topic for biodiversity conservation. Here we report a comprehensive classification of plant communities in the highest altitudinal belt of the Picos de Europa, a biodiversity hotspot of Northern Iberian Peninsula. We compiled vegetation plot data sampled in the three calcareous massifs from 1800 to 2600 m.a.s.l., and analysed species composition by using cluster analyses and Nonmetric Multidimensional Scaling (NMDS). Optimal classification and the interpretation of multivariate analyses allowed us to recognize two major vegetation types and six clusters that were characterized by their floristic composition, altitudinal range and phytosociological classification. The first vegetation type (alliance *Festucion burnatii*, class *Festuco hystricis-Ononidetea*) corresponds to stripped habitats subjected to cryoturbation and represented by two community types (*Helianthemo cantabrici-Festucetum hystricis* ass. nova and *Jasiono cavanillesii-Helictotrichetum sedenensis* ass. nova). A second vegetation type includes alpine-like communities with higher biomass (alliance *Armerion cantabricae*, class *Festuco-Seslerietea*) represented by snow-bed (*Ranunculo carinthiaco-Poetum alpinae* ass. nova), mesophilous (ass. *Pediculari fallacis-Armerietum cantabricae*) and scree (*Saxifrago coniferae-Helianthemetum urrielensis* ass. nova) grasslands; and relict wind-edge swards (alliance *Oxytropido-Elynion*, class *Carici rupestris-Kobresietea myosuroides*) represented by relict alpine communities (ass. *Oxytropido neglectae-Kobresietum myosuriodis*). Our results highlight the Picos de Europa as a unique refuge for alpine vegetation and demonstrate historical relationships with both Alpine-Pyrenean and Iberian mountain ranges.

Keywords: alpine flora, *Armerion cantabricae*, Cantabrian range, *Festucion burnatii*, Iberian Peninsula, Picos de Europa, mountain refugia, *Oxytropido-Kobresion myosuroidis*, plant communities, vegetation classification.

Resumen: Jiménez-Alfaro, B., Alonso Felpete, J.I., Bueno Sánchez, A. & Fernández Prieto, J.A. *Comunidades alpinas de los macizos calizos de los Picos de Europa (norte de España). Lazaroa 35: 67-105 (2014).*

Las montañas del sur de Europa son importantes refugios para plantas adaptadas al frío, por lo que la caracterización de la vegetación en estas regiones tiene una especial relevancia para la conservación de la biodiversidad. En este estudio realizamos una clasificación de las comunidades vegetales del piso altitudinal más elevado de los Picos de Europa, un centro de biodiversidad del norte de la Península Ibérica. Recolectamos datos de vegetación inventariados en parcelas de los tres macizos calcáreos de Picos de Europa entre 1800 y 2600 metros de altitud, y analizamos la composición de especies mediante análisis aglomerativo y ordenación NMDS. A partir de una clasificación optimizada y la interpretación del análisis multivariante reconocemos dos tipos principales de vegetación y seis grupos básicos, los cuales se caracterizaron por su composición florística, rango altitudinal y clasificación fitosociológica. El primer tipo de vegetación (allianza *Festucion burnatii*, clase *Festuco hystricis-Ononidetea*) se corresponde con habitats desnudos sometidos a crioturbación y representados por dos comunidades (*Helianthemo cantabrici-Festucetum hystricis* ass. nova y *Jasiono cavanillesii-Helictotrichetum sedenensis* ass. nova.). Un segundo tipo de vegetación (allianza *Armerion cantabricae*, clase *Festuco-Seslerietea*) está representado por comunidades herbáceas de neveros (*Ranunculo carinthiaco-Poetum alpinae* ass. nova), praderas mesófilas (*Pediculari fallacis-Armerietum cantabricae*) y pedregales (*Saxifrago coniferae-Helianthemetum urrielensis* ass. nova); y también por praderas de crestas venteadas (allianza *Oxytropido-Elynion*, class *Carici rupestris-Kobresietea myosuroides*) con comunidades relícticas (*Oxytropido neglectae-Kobresietum myosuroidis*). Nuestros resultados destacan el carácter de los Picos de Europa como especial refugio para la vegetación alpina, evidenciando las relaciones históricas con las montañas alpino-pirenaicas y también ibéricas.

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Palabras clave: flora alpina, *Armerion cantabricae*, Cordillera Cantábrica, *Festucion burnatii*, Península Ibérica, Picos de Europa, refugios de montaña, *Oxytropido-Kobresion myosuroidis*, comunidades vegetales, clasificación de la vegetación.

INTRODUCTION

Mountain ecosystems are among the most valuable habitats for biodiversity and conservation (Nagy & Grabherr, 2009; Gavilán & *al*., 2013). In the mountains of southern Europe, plant diversity has been historically influenced by post-glacial isolation and related processes such as local extinctions and speciation (Taberlet & *al*., 1998). Due to recent climatic change, mountain habitats are also experiencing important changes in vegetation diversity (Pauli & *al*., 2012; Fernández Calzado & Molero Mesa, 2013; Jiménez-Alfaro & *al*., 2014a). Addressing diversity patterns at community level is therefore important for understanding mountain habitats and for developing conservation actions in alpine landscapes (Gavilán & *al*., 2012). Among different approaches, vegetation surveys based on the classification of plot data provide useful information for synthesizing the variation of plant communities into vegetation types (Blasi & *al*., 2005; Lancioni & *al*., 2011; Peyre & Font, 2011; Noroozi & *al*., 2014) and for defining spatial patterns of alpine ecosystems (Dirnbök & *al*., 2003; Fernández Calzado & Molero Mesa, 2011).

In this study, we focus on the classification of alpine communities in the Picos de Europa National Park (northern Spain). The study system comprises vegetation above the treeline dominated by hemicryptophytes and chamaephytes, and representing an important outspot of zonal alpine plant diversity in southern Europe (Nagy & Grabherr, 2009). This vegetation has been traditionally related to the subalpine and alpine altitudinal belts, bioclimatically corresponding to the orotemperate and criorotemperate types (Alonso Felpete & *al*., 2011 Rivas-Martínez & *al*., 2011). Indeed, dominant plant communities are structured by alpine species with different biogeographic origin that respond synchronically to local topographic gradients (Jiménez-Alfaro & *al*., 2014b). Although several plant communities have been described based on floristic, phytosociological or mapping surveys (Rivas-Martínez& *al*., 1984; Nava, 1988; Fernández Prieto & Bueno, 2013), there is still lacking a comprehensive classification of alpine-like vegetation in the Picos de Europa.

According to the vegetation classification of the Iberian Peninsula (Rivas-Martínez & *al*., 2001, 2002), high-mountain vegetation of the Cantabrian mountains is floristically related to three major types: (i) Alpine-Pyrenean-Carpathian alpine communities (class *Kobresio myosuroidis-Seslerietea caeruleae*) mainly distributed in the Picos de Europa and the Ubiña massifs (Rivas-Martínez & *al*., 1984); (ii) Alpine-Pyrenean-Carpathian swards dominated by *Kobresia myosuroides* (class *Carici rupestris-Kobresietea myosuroidis*) only found in the central massif of the Picos de Europa, and (iii) high-mountain communities of the class *Festuco hystricis-Ononidetea striatae*, mainly represented in continental areas of the central Cantabrian range (Martínez & Mayor, 1974; Amigo & *al*., 1993). Here, we compile vegetation plot data from the Picos de Europa to assess the diversity of species assemblages in these major vegetation types. Our main objectives are (1) to classify local alpine communities according to their floristic composition, (2) to interpret the resulting vegetation types in floristic and ecological terms and (3) to link our results with the phytosociological classification of the Iberian Peninsula.

MATERIALS AND METHODS

We built a vegetation-plot database consisting on complete lists of vascular plants (relevés) sampled according to the Braun-Blanquet method (Braun-Blanquet, 1979) above 1800 m.a.s.l. in the three calcareous massifs of the Picos de Europa (Figure 1). Main data sources were collected from vegetation surveys (Rivas-Martínez & *al*., 1984; Jiménez-Alfaro & *al*., 2014b) and for the

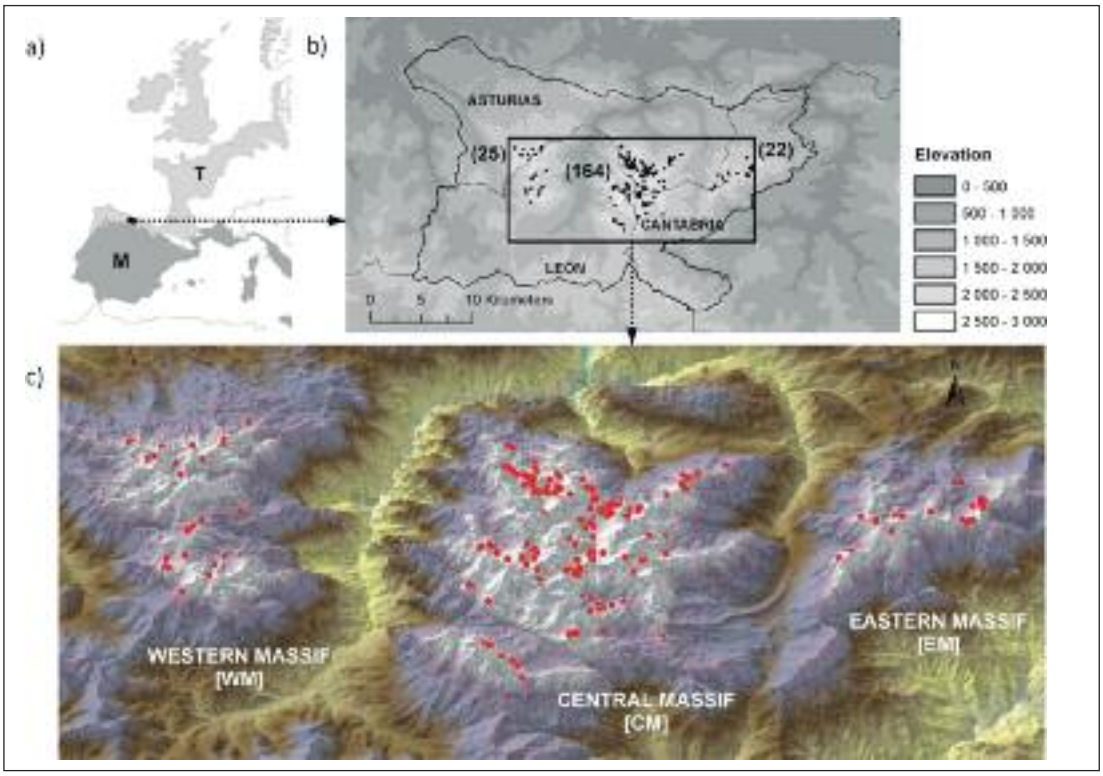

Figure 1. – Study area and distribution of the vegetation plots analysed. (a) Location of Picos de Europa National Park in the border between Temperate-Atlantic (T) and Mediterranean (M) biogeographic regions. (b) Location and number of relevés in the Picos de Europa National Park (c) Spatial distribution of relevés with reference to the three calcareous massifs of Picos de Europa.

development of the vegetation map of the Picos de Europa (Fernández Prieto & Bueno, 2013). To obtain a relatively homogeneous data set, only relevés sampled in areas from 10 to 100 m^2 were considered, since these are the most frequently sampled plot areas. In a few relevés where this information was not available, we estimated the plot size by comparing species richness of similar communities to remove outliers potentially sampled in smaller or larger areas. The data were stored in a database using Turboveg V.2 (Hennekens & Schaminée 2001). Taxonomical concepts were standardized according to Flora Iberica (www.floraiberica.org), although in particular cases the nomenclature follows the floristic catalogue of the Picos de Europa National Park (Alonso Felpete & *al*., 2011).

We classified the plots using cluster analyses in PC-ORD 4 (Mccune & Mefford, 1999) with the Bray-Curtis distance as a measure of dissimilarity and the beta-flexible linkage method with coefficient β = -0.25. Species percentage cover was log transformed. The optimal number of clusters was established by using the crispness of classification (Botta-Dukat & *al*., 2005) as a guide to optimize the structure of the data. Non-metric Dimensional Scaling (NMDS) (Kruskal, 1964) implemented in the R program, library "*vegan*" (Oksanen & *al*., 2013) was applied to assess the similarities of the established groups in the multidimensional space. The resulting clusters were characterized by sorting their diagnostic species in a synoptic table by using the *phi* coefficient of association and a Fisher exact test to detect significant preferences to groups (Tichy & Chytrý, 2006). To obtain a comparative measure of the species characterizing each cluster, we counted the number of diagnostic species with

significant ($P < 0.05$) *phi* coefficient > 30. We assessed differences in altitude and species cover between clusters using the values provided for each plot by the original sources and the ANOVA test with post-hoc classification.

Vegetation types were finally described by their physiognomic characteristics and species composition, and compared with the vegetation types included in the classification of plant communities of the Iberian Peninsula (Rivas-Martínez & *al*., 2001, 2002, 2011). For those plant communities identified as distinct associations but not described before, we propose new syntaxa following the rules of the International Code of Phytosociological Nomenclature (Izco & Del Arco, 2003). The nomenclature of the new communities was based on the species recognized as characteristics of the vegetation type and the presence of endemic species, following the preliminary proposals used for vegetation mapping in the study area (Fernández Prieto & Bueno, 2013).

RESULTS AND DISCUSSION

A total of 211 vegetation plots were selected, including 214 species of vascular plants. The most frequent species in the data set were *Anthyllis vulneraria* (80% of the plots), *Thymus praecox* subsp. *britannicus* (80%), *Carex sempervirens* (74%), *Silene acaulis* (71%) and *Minuartia verna* (67%). The crispness of classification suggested an optimal number of 6 clusters (maximum crispness = 0.658) with differences in species composition (Figure 2) that were also supported by relative differences in altitude and cover (Figure 3). The resulting dendrogram recognized two major branches and the six clusters were distinctly identified in the NMDS ordination diagram (Bray-Curtis distance, total stress = 32.4). The first branch included two clusters (cluster 1 and cluster 2) clearly differentiated from the others but also between each other, with contrasting differences in altitude and cover (Figure 3). The remaining plots were separated in two branches, being the first one (clusters 3 and cluster 4) more homogeneous in species composition and altitude than the second one (clusters 5 and cluster 6). The diagnostic species that characterize each community type are showed in Table 1, and a representative image of their physiognomic characteristics is presented in Figure 4.

CLUSTER 1 corresponds to stripped communities characterized by *Jurinea humilis, Koeleria*

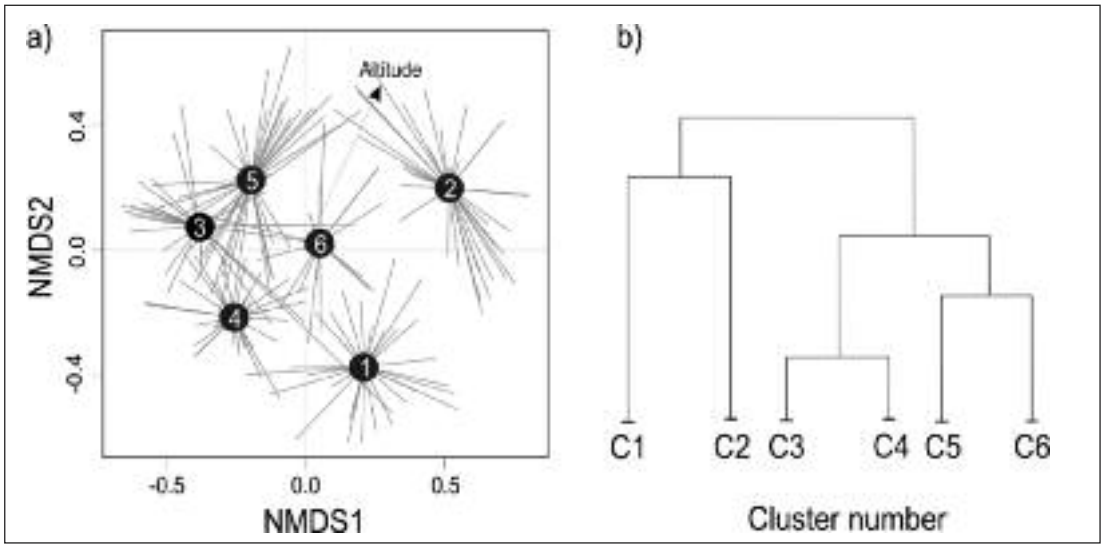

Figure 2. – (a) Ordination plot of the two main axes of Nonmetric Dimensional Scaling (NMDS) showing the centroids of the six clusters identified in this study, and their correlation with altitude. (b) Hierarchical division of the clusters according to the classification of the relevés (n =211).

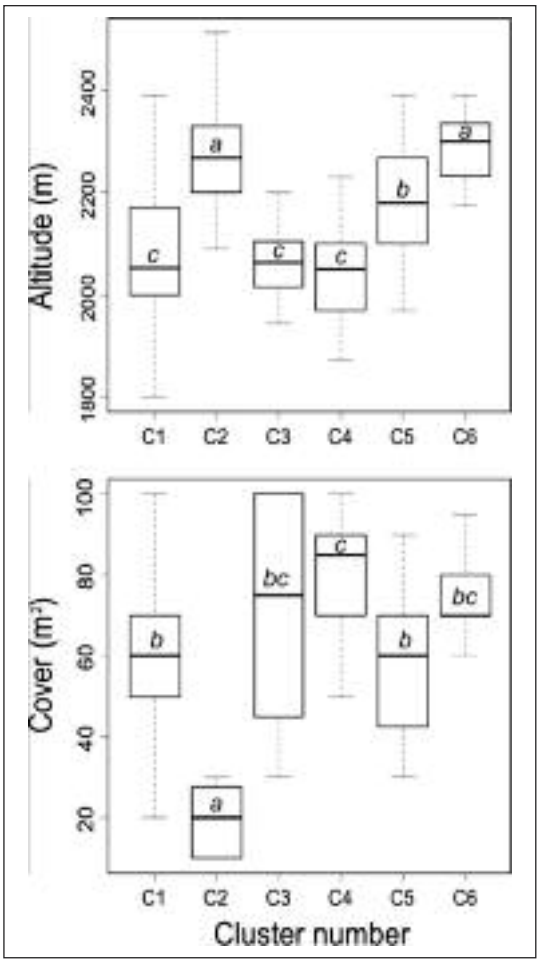

Figure 3. – Differences in altitude and cover between the six clusters identified by cluster analyses in alpine plant communities of the Picos de Europa. Letters indicate differences according to an ANOVA post-hoc test.

vallesiana and *Helianthemum canum* subsp. *cantabricum* among a total of eight diagnostic species. These communities are found at relatively low altitudes (Figure 4) and many of the constituent species are distributed in other mountains of the Iberian Peninsula (e.g. *Jurinea humilis*). They are easily characterized in the field by evidences of soil cryoturbation (repetition of freezing and thawing processes in periglacial zones, Amico & Previtali, 2012). Similar communities with Mediterranean influence have been described in dry stands of the Cantabrian range under the phytosociological alliance *Festucion burnatii*, including the associations *Arenario cantabricae-Festucetum hystricis* (Martínez & Mayor, 1974), *Festucetum burnatii* (Fernández Prieto, 1983), *Koelerio vallesianae-Erodietum glandulosi* (Amigo & *al*., 1993), *Saxifrago coniferae-Festucetum burnatii* (Fernández Prieto & *al*. 1983) and *Festucetum burnatii* (Mayor & *al*., 1973; Rivas-Martínez & *al*., 1984). However, the floristic composition of the cluster 1 is clearly different in species composition, with species combinations not represented in previously described communities. We therefore typify a new association, *Helianthemo cantabrici-Festucetum hystricis* F. Prieto, Bueno, Jiménez-Alfaro & A. Felpete *ass. nova hoc loco* (Appendix, Table S1, *holotypus* rel. 24) broadly described in the vegetation map of the study area (Fernández Prieto & Bueno, 2013: 159) under the type "10.7b2. Cespedes psicroxerófilos calcícolas del *Androsaco villosae-Festucetum hystricis*". The name *Androsaco villosae-Festucetum hystricis* has been validly published in the past (Navarro, 1989) and hence it cannot be used to nominate this association.

CLUSTER 2 corresponds to stripped communities with low plant cover characterized by *Jasione cavanillesii, Potentilla nivalis* subsp. *asturica, Galium pyrenaicum* and a total of nine diagnostic species (Table 1). These communities are found at the highest altitudes of the study area (Figure 4) and they are mainly distributed on rocky soils. They occur where snow melt happens early due to topographic top positions that favour the snow-clean effect by strong wind exposures and also prevent the formation of deep soils. Although these communities include a few arctic-alpine species (e.g. *Silene acaulis*) the species composition (Appendix, Table S2) is characterized by indicators of dry and cryoturbated soils (e.g. *Senecio boissieri*) reflecting strong connections with the high-mountain Iberian flora (Peredo & *al*., 2009). Thus, these communities were ascribed to the *Festucion burnatii* alliance. They have been described in Fernández Prieto & Bueno (2013: p.194) under the vegetation type "14.1a Nanofruticedas cespitosas con *Galium pyrenaicum* y *Helictotrichon sedenense*" and the association *Jasiono cavanillesii-Helictotrichetum sedenensis* Prieto & Bueno ined. (= *Galio pyrenaici-Helictotrichetum sedensis* Prieto & Bueno

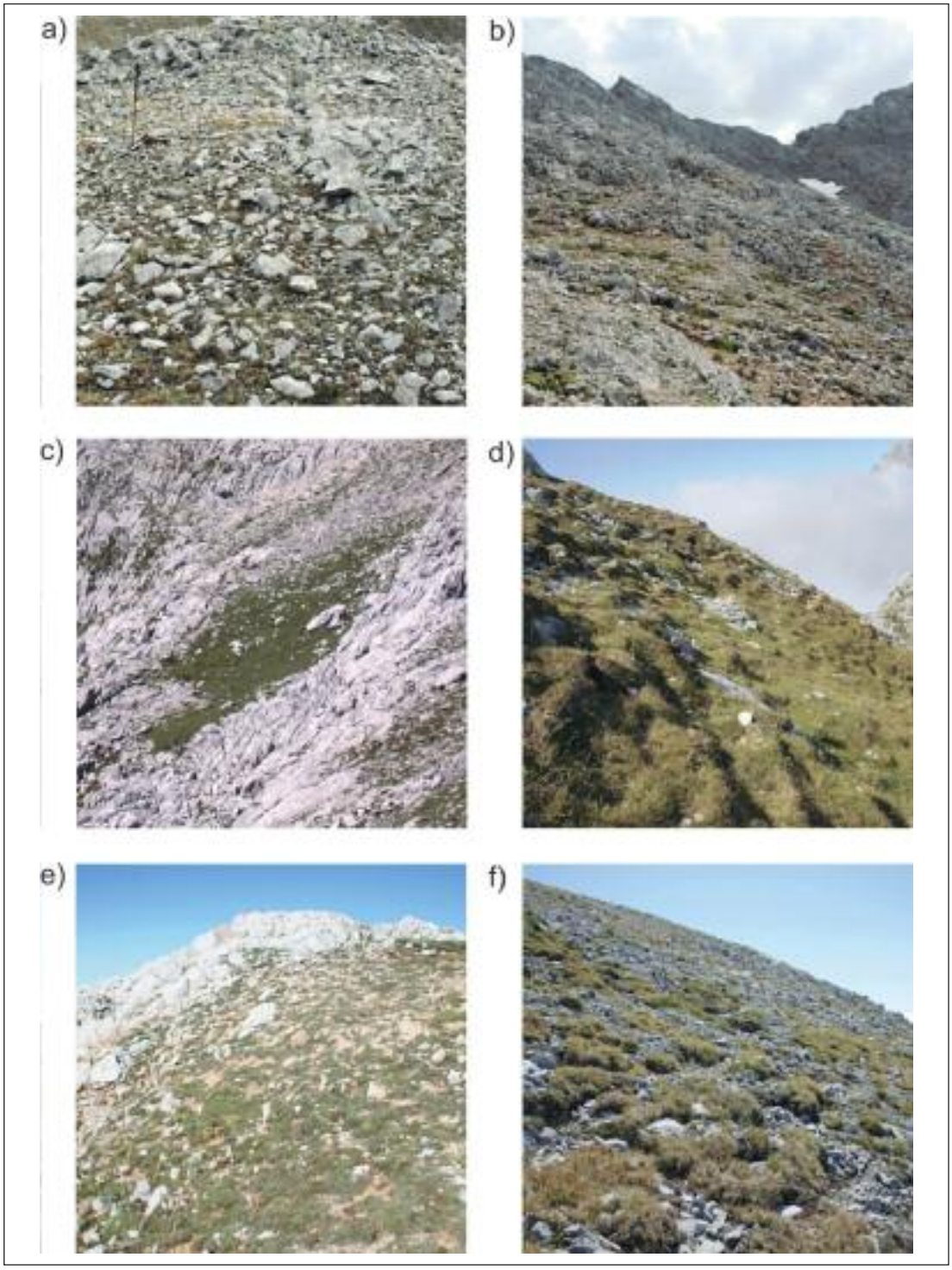

Figure 4. – Representative images of the six clusters (associations) identified in calcareous massifs of the Picos de Europa: (a) *Helianthemo cantabrici-Festucetum hystricis* (b) *Jasiono cavanillesii-Helictotrichetum sedenensis* (c) *Ranunculo carinthiaco-Poetum alpinae* (d) *Pediculari fallacis-Armerietum cantabricae* (e) *Saxifrago coniferae-Helianthemetum urrielensis* and (f) *Oxytropido neglectae-Kobresietum myosuroidis*.

ined.). The absence of tables and thus the lack of designated typus lead us to typify the association *Jasiono cavanillesii-Helictotrichetum sedenense* Bueno, F. Prieto, Jiménez-Alfaro & A. Felpete *ass. nova hoc loco* (Appendix, Table S2, *holotypus* rel. 6) as a new sintaxa probably exclusive of the Picos de Europa National Park.

CLUSTER 3 corresponds to snow-bed grasslands characterized by *Ranunculus carinthiacus, Poa alpina, Carex macrostylon* and a total of eight diagnostic species (Table 1). These communities are mainly found in stands where snow accumulates for long, favouring the development of high-cover grasslands in the north-facing slopes of the alpine belt. They are ecologically similar to the phytosociological association described in the Pyrenees as *Festuco-Trifolietum thalii* Br.-Bl 1948 (alliance *Primulion intricatae*). The floristic composition with *Armeria cantabrica, Pedicularis pyrenaica* var. *fallax, Dethawia splendens, Jasione cavanillesii* and *Silene ciliata* lead us to include this association in the Cantabrian alliance *Armerion cantabricae*, the Cantabrian vicariant of *Primulion intricatae*. These plant communities have been described in Fernández Prieto & Bueno (2013: 196) under the vegetation type "14.1c Céspedes con *Poa alpina*" and the association *Ranunculo carinthiaco-Poetum alpine*. Since this name was not validly published according to article 5 of the International Code of Phytosociological Nomenclature, we proceed to the mandatory typification of *Ranunculo carinthiaco-Poetum alpinae* F. Prieto, Bueno, Jiménez-Alfaro & A. Felpete *ass. nova hoc loco* (Appendix 1, Table S3, *holotypus* rel. 10).

CLUSTER 4 corresponds to high-cover grasslands characterized by *Sesleria caerulea, Luzula pediformis, Polygonum viviparum* and a total of 28 diagnostic (species (Table 1). These communities occur at relatively low altitudes; they show higher plant height than the cluster 3 and they probably grow in topographic stands with shorter periods of snow cover. According to the species composition (Appendix, Table S4), they can be ascribed to the association *Pediculari fallacis-Armerietum cantabricae*, which is the community of reference for the alliance *Armerion cantabricae* in the Picos de Europa (Rivas-Martínez & *al*., 1984).

CLUSTER 5 corresponds to high-altitude communities characterized by *Festuca glacialis, Veronica nummularia* subsp. *cantabrica, Omalotheca hoppeana* and a total of 11 diagnostic species (Table 1). According to the ecology of their characteristic species, these communities are probably linked to late snow-melt and periglacial processes that favour the development of screes. Although these communities seem to be mainly related to intermediate conditions between clusters 2 and 4, i.e. with certain snow persistence (indicated by *Omalotheca hoppeana* or *Festuca glacialis*) but also with dry conditions (indicated by *Saxifraga conifera* or *Arenaria moehringioides*), the species combination is to our known genuine from the Picos de Europa and widely represented in local dolomitic screes. Thus, we describe a new association typified as *Saxifrago coniferae-Helianthemetum urrielensis* Bueno, F. Prieto, Jiménez-Alfaro & A. Felpete *ass. nova hoc loco* (Appendix 1, Table S5, *holotypus* rel. 42), previously described in Fernández Prieto & Bueno, 2013: 254).

CLUSTER 6 corresponds to wind-edge swards characterized by *Kobresia myosuriodes, Oxytropis halleri, Arenaria grandiflora* and a total of five diagnostic species (Table 1). The ecological preference of the dominant *Kobresia myosuroides* is commonly related to wind-edge sites with deept soils where snow melts early (Baptist & *al*., 2010). Similar conditions occur in the study area, where *Kobresia* communities are developed at the highest altitudes and also settled in microtopographic windy tops. They are relict communities of the *Kobresia* swards widely repreesnted in the Alpine-Pyrenean-Carpathian mountains, locally occuring in less than 20 sites restricted to the central massif of the Picos de Europa. The species composition closely corresponds to the phytosociological association *Oxytropido neglectae-Kobresietum myosuriodis* nom. mut propos. Rivas-Martínez & *al*. 2002, also recognized by Nava (1988: table 14) as "Comunidades con *Elyna myosuroides*". The association *Oxytropidetum neglecto-halleri* recently described by Rivas-Martínez & *al*. (2011) seems to be a variant of these communities with absence of *Kobresia myosuroides*. However, the species list provided

Table 1
Shortened synoptic table of diagnostic species for the groups resulted from cluster analyses
Numbers refer to the percentage frequency of species in each cluster. Diagnostic species are in bold and sorted by decreasing fidelity. Only significant species (Fisher´s exact test, $p < 0.05$) with *phi* coefficient > 0.30 are shown.

Cluster	1	2	3	4	5	6
Number of relevés	34	42	24	39	51	21
Cluster 1						
Jurinea humilis	**68**	0	4	23	0	14
Koeleria vallesiana	**97**	43	13	72	25	33
Juniperus alpina	**21**	0	4	3	0	0
Helianthemum canum subsp. *cantabricum*	**100**	76	21	62	35	90
Festuca hystrix	**47**	29	8	8	4	14
Globularia repens	**41**	38	4	8	0	0
Genista legionensis	**18**	0	4	3	0	0
Androsace villosa	**76**	55	4	62	8	52
Cluster 2						
Jasione cavanillesii	3	**81**	0	8	29	24
Potentilla nivalis subsp. *asturica*	12	**55**	0	5	0	0
Senecio boissieri	0	**38**	0	0	0	0
Saxifraga oppositifolia	15	**83**	8	13	25	14
Galium pyrenaicum	50	**100**	4	10	41	57
Iberis carnosa	18	**74**	13	8	33	5
Helictotrichon sedenense	74	**100**	21	46	41	90
Silene ciliata	29	**81**	13	38	57	52
Ranunculus parnassiifolius subsp. *favargeri*	15	**50**	13	0	18	33
Cluster 3						
Carex macrostylon	0	0	**33**	0	2	0
Phleum alpinum	0	0	**33**	0	0	5
Trifolium thalii	0	0	**42**	8	2	14
Ranunculus carinthiacus	15	0	**71**	44	39	5
Carex parviflora	0	5	**50**	3	14	38
Festuca nigrescens s.l.	0	0	**25**	8	6	0
Plantago alpina	26	0	**75**	59	63	14
Pritzelago alpina subsp. *auerswaldii*	3	7	**38**	21	12	0
Cluster 4						
Sesleria caerulea	3	0	4	**41**	0	10
Luzula pediformis	12	0	29	**64**	18	19
Polygonum viviparum	0	5	0	**41**	16	10
Festuca rubra s.l.	9	0	38	**56**	22	0
Leontodon taraxacoides	3	0	0	**18**	0	0
Alchemilla alpigena	26	10	67	**85**	61	29
Gentiana occidentalis	21	0	0	**28**	2	0
Scilla verna	6	0	4	**26**	10	0
Oxytropis halleri	0	2	0	**15**	2	0
Cluster 5						
Festuca glacialis	6	43	21	10	**84**	29
Veronica nummularia subsp. *cantabrica*	0	2	0	0	**27**	0
Omalotheca hoppeana	0	2	25	5	**45**	0
Saxifraga conifera	62	17	38	62	**90**	24
Arenaria moehringioides	12	33	8	18	**57**	14
Festuca picoeuropeana	9	2	0	3	**35**	24
Sedum atratum	21	19	13	31	**59**	29
Cluster 6						
Kobresia myosuroides	3	19	0	13	4	**90**
Oxytropis neglecta	3	12	8	5	4	**52**
Arenaria grandiflora	0	2	0	15	6	**33**
Carex ornithopoda s.l.	6	7	4	0	24	**38**
Seseli montanum	3	0	0	5	0	**19**

by the authors in only one relevé reflects a complex mosaic of ecological conditions, therefore postponing its validity until the collection of new data.

CONCLUSIONS

In this study we described the alpine vegetation of the Picos de Europa National Park by using a comprehensive data set covering the three calcareous massifs. Overall, we detected two major vegetation types based on floristic composition but also differentiated in ecological terms. The first vegetation type is characterized by stripped communities here ascribed to the alliance *Festucion burnatii*, representing xerophilous mountain communities subjected to cryoturbation processes previously described in the highest altitudinal belt of the Picos de Europa (RIVAS-MARTÍNEZ & *al*., 1984, NAVA, 1988; JIMÉNEZ-ALFARO & *al*., 2014b). These communities are characterized by medium-to-low species cover and by the presence of species commonly found in high-mountain Iberian habitats (e.g. *Festuca hystrix, Helianthemum canum, Senecio boissieri*). A second vegetation type was ascribed to the Cantabrian alliance *Armerion cantabricae*, which is characterized by alpine mesophilous species (e.g. *Alchemilla alpigena, Plantago alpina, Luzula pediformis*) probably reflecting deeper soils and longer periods of snow cover. This group is mainly represented from 2000 to 2200 m asl, where the presence of microtopographies with snow accumulation is more likely to occur than in higher altitudes.

Our study also showed that the diversity of alpine plant communities in the Picos de Europa can be synthesized in six phytosociological associations differentiated by a relatively high number of diagnostic species. This reflects a higher diversity of alpine vegetation than previously observed in vegetation surveys of the study area (RIVAS-MARTÍNEZ & *al*., 1984, NAVA, 1988) and supports the typology used for the vegetation map of the Picos de Europa National Park (FERNÁNDEZ PRIETO & BUENO, 2013). Our results also agree with some of the alpine communities identified by NAVA (1988), despite we couldn't include these data because of the different sampling criteria and the small plot size used by this author. Moreover, the floristic and ecological differences between clusters support the complexity of local alpine communities with different ecological responses (JIMÉNEZ-ALFARO & *al*., 2014b). The relatively high diversity of alpine communities in the Picos de Europa is comparable with wider regions of Southern Europe such as the Apennines (LANCIONI & *al*., 2011), despite in the latter region the influence of the Alpine floristic component is stronger. In contrast, the vegetation of the calcareous massif of the Picos de Europa is referred to phytosociological classes from both Temperate and Mediterranean bioclimatic regions, which are much more influenced by the Iberian floristic component. This highlights the biogeographic relevance of plant diversity in the Picos de Europa National Park and provides an additional argument for the conservation of this important centre of mountain diversity.

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SYNTAXONOMIC SCHEME

Syntaxonomical synopsis of alpine communities in the Picos de Europa according to the present study, adscribed to the phytosociological classification of the Iberian Peninsula (RIVAS-MARTÍNEZ & *al.*, 2001, 2002).

FESTUCO HYSTRICIS-ONONIDETEA STRIATAE Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 2002
FESTUCO HYSTRICIS-POETALIA LIGULATAE Rivas Goday & Rivas-Martínez 1963
Festucion burnatii Rivas Goday & Rivas-Martínez ex Mayor, Andrés, Martínez, F. Navarro & T.E. Díaz 1973
Helianthemo cantabrici-Festucetum hystricis F. Prieto, Bueno, Jiménez-Alfaro & A. Felpete *ass. nova* (cluster 1)
Jasiono cavanillesii-Helictotrichetum sedenensis Bueno, F. Prieto, Jiménez-Alfaro & A. Felpete *ass. nova* (cluster 2)

KOBRESIO MYOSUROIDIS-SESLERIETEA CAERULEAE Br.-Bl. 1948 nom. mut. propos. Rivas-Martínez et al. 2002
SESLERIETALIA CAERULEAE Br.-Bl. in Br.-Bl. & Jenny 1926
Armerion cantabricae Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
Ranunculo carinthiaco-Poetum alpinae F. Prieto, Bueno, Jiménez-Alfaro & A. Felpete *ass. nova* (cluster 3)
Pediculari fallacis-Armerietum cantabricae Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984 (cluster 4)
Saxifrago coniferae-Helianthemetum urrielensis Bueno, F. Prieto, Jiménez-Alfaro & A. Felpete *ass. nova* (cluster 5)

CARICI RUPESTRIS-KOBRESIETEA MYOSUROIDIS Ohba 1974 nom. mut. propos. Rivas-Martínez et al. 2002
KOBRESIETALIA MYOSUROIDIS Oberdorfer 1957 nom. mut. propos. Rivas-Martínez et al. 2002
Oxytropido-Kobresion myosuroidis Br.-Bl. (1948) 1949 nom. mut. propos. Rivas-Martínez et. al 2002
Oxytropido neglectae-Kobresietum myosuroidis Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984 nom. mut. propos. Rivas-Martínez et al. 2002 (cluster 6)

REFERENCES

Alonso Felpete, J.I., González Robinson, S., Fernández Rodríguez, A., Sanzo Rodríguez, I., Cabello de Alba, A., Bueno Sánchez, A. & Díaz González, T.E. —2011— Catálogo florístico del Parque Nacional Picos de Europa — Doc. Jard. Bot. Atlántico 8: 1-310.

Amigo, J., Giménez de Azcárete, J. & Izco, J. —1993— Las comunidades de la clase Ononido-Rosmarinetea Br.-Bl. 1947 en su límite noroccidental ibérico (Galicia-NO de España) — Bot. Complutensis 18: 213-229.

Amico, M.E.D. & Previtali, F. —2012— Edaphic influences of ophiolitic substrates on vegetation in the Western Italian Alps — Plant Soil 351: 73-95.

Baptist, F., Yoccoz, N.G. & Choler, P. —2010— Direct and indirect control by snow cover over decomposition in alpine tundra along a snowmelt gradient — Plant Soil 328: 397-410.

Blasi, C., Di Pietro, R. & Pelino, G. —2005— The vegetation of alpine belt karst-tectonic basins in the central Apennines (Italy) — Plant Biosyst. 139: 357-385.

Botta-Dukát, Z., Chytrý, M., HáJková, P. & Havlová, M. —2005— Vegetation of lowland wet meadows along a climatic continentality gradient in Central Europe — Preslia 77: 89-111.

Braun-Blanquet, J. —1979— Fitosociología. Bases para el estudio de las comunidades vegetales — Hermann Blume Ed., Madrid. 832 pp.

Dirnböck, T., Dullinger, S., Gottfried, M., Ginzler, C. & Grabherr, G. —2003— Mapping alpine vegetation based on image analysis, topographic variables and Canonical Correspondence Analysis — App. Veg. Sci. 6: 85-96.

Fernández Calzado, M.R. & Molero Mesa, J. —2011— The cartography of vegetation in the cryoromediterranean belt of Sierra Nevada: a tool for biodiversity conservation — Lazaroa 32: 101-115.

Fernández Calzado, M.R. & Molero Mesa, J. —2013— Changes in the summit flora of a Mediterranean mountain (Sierra Nevada, Spain) as a possible effect of climate change — Lazaroa 34: 65-75.

Fernández Prieto, J.A. —1983— Aspectos geobotánicos de la Cordillera Cantábrica — An. Jard. Bot. Madrid 39(2): 489-513.

Fernández Prieto, J.A. & Bueno, A. —2013— Mapa de vegetación 1:10.000 del Parque Nacional Picos de Europa. Memoria de análisis global de la vegetación del Parque Nacional Picos de Europa — Organismo Autónomo Parques Nacionales, Ministerio de Agricultura, Alimentación y Medio Ambiente. Madrid.

Gavilán, R.G., Díez-Monsalve, E., Izquierdo, J.L., Gutiérrez-Girón, A., Fernández-González, F. & Sánchez-Mata, D. —2012— An approach towards the knowledge of Iberian high mountain calcareous grasslands — Lazaroa 33: 43-50.

Gavilán, R.G., Jiménez-Alfaro, B., Bacchetta, G., Dimopoulos, P. & Mucina, L. —2013— Mountain biodiversity patterns in Southern Europe and North Africa — Lazaroa 34: 7-10.

Hennekens, S.M. & Schaminee, J.H.J. —2001— Turboveg, a comprehensive database management system for vegetation data — J. Veg. Sci. 12: 589-591.

Izco, J., Del Arco, M. [Weber, H.E., Moravec, J. & Theurillat, J.P.; translation of 3th official edition] —2003— Código internacional de nomenclatura fitosociológica — Materiales didácticos universitarios. Ser. Bot. 2. Serv. Publ. Univ. La Laguna, La Laguna.

Jiménez-Alfaro, B., Gavilán, R.G., Escudero, A., Iriondo, J.M. & Fernández González, F. —2014(a)— Decline of dry grassland specialists in Mediterranean high-mountain communities influenced by recent climate warming — J. Veg. Sci. 25: 1394-1404.

Jiménez-Alfaro, B., Marcenó, C., Bueno, A., Gavilán, R. & Obeso, J.R. —2014(b)— Biogeographic deconstruction of alpine plant communities along altitudinal and topographic gradients — J. Veg. Sci. 25:160-171.

Lancioni, A., Facchi, J. & Taffetani, F. —2011— Syntaxonomical analysis of the Kobresio-Myosuroidis-seslerietea caeruleae and Carici Rupestris-Kobresietea Bellardii classes in the central southern Apennines — Fitosociologia: 48: 3-2.

Kruskal, J.B. —1964— Nonmetric multidimensional scaling: a numerical method — Psychometrika 29: 115-129.

Martínez, G. & Mayor, M.—1974— Estudio fitosociológico y fitotopográfico de las vertientes septentrional y meridional del Puerto de Ventana — Rev. Fac. Cienc. Oviedo 15(1): 55-109.

Mayor, M., Andrés, J., Martínez, G, Navarro, F. & Díaz, T.E —1973— Estudio de los pastizales de diente y siega en algunas localidades de la Cordillera Cantábrica con especial atención al comportamiento ecológico de Festuca hystris Boiss. — Rev. Fac. Cienc. Oviedo 14(2): 161-171

McCune, B. & Mefford, M.J. —1999— PC-ORD. Multivariate Analysis of Ecological Data, Version 4.0 — MjM Soft. Des. Gleneden Beach, Oregon. 237 pp.

Nagy, L. & Grabherr, G. —2009— The Biology of Alpine Habitats — Oxford Univ. Press, Oxford.

Nava, H.S. —1988— Flora y vegetaciónn orófila de los Picos de Europa — Ruizia 6: 1-243.

Navarro, G. —1989— Contribución al conocimiento de la vegetación del Moncayo — Opusc. Bot. Pharm. Complut. 5: 5-64.

Noroozi, J., Willner, W., Pauli, H. & Grabherr, G. —2014— Phytosociology and ecology of the high-alpine to subnival scree vegetation of N and NW Iran (Alborz and Azerbaijan Mts.) — App. Veg. Sci. 142: 142-161.

Oksanen, J., Guillaume Blanchet, F., Kindt, R., Legendre, P., Minchin, P.R., O'Hara, R.B., Simpson, G.L., Solymos, P., Henry, M., Stevens, H. & Wagner, H. —2013— vegan: Community Ecology Package. R package version 2.0-6. http://CRAN.R-project.org/package=vegan.

Pauli, H., Gottfried, M., Dullinger, S., Abdaladze, O., Akhalkatsi, M., Benito, J.L., Coldea, G., Dick, J., Erschbamer, B., Fernández, MR., Goshn, D., Holten, J.I., Kanka, R., Kazakis, G., Kollár, J., Larsson, P., Moiseev, P., Moiseev, D., Molau, U., Molero Mesa, J., Nagy, L., Pelino, G., Puscas, M., Rossi, G., Stanisci, A., Syverhuset, A.O., Theurillat, J.P., Tomaselli, M., Unterluggauer, P., Villar, L., Vittoz, P. & Grabherr, G. —2012— Recent Plant Diversity Changes on Europe's Mountain Summits — Science 336: 353-355.

Peredo, E.L., Revilla, M.A., Jiménez-Alfaro, B., Bueno, A., Fernández Prieto, J.A. & Abbott, R. —2009— Historical biogeography of a disjuntly distributed, Spanish alpine plant, Senecio boissieri (Compositae) — Taxon 58: 883-892.

Peyre, G. & Font, X. —2011— Syntaxonomic revision and floristic characterization of the phytosociological alliances corresponding to subalpine and alpine grasslands of the Pyrenees and Cantabrian Mountains classes Caricetea curvulae, Carici-Kobresietea, and Festuco-Seslerietea — Plant Biosyst. 145: 220-232.

Rivas-Martínez, S., Díaz, T.E., Fernández Prieto, J.A., Loidi, J. & Penas, A. —1984— La vegetación de la alta montaña cantábrica. Los Picos de Europa — Ed. Leonesas, Madrid.

Rivas-Martínez, S., Fernández-González, F., Loidi, J., Lousã, M. & Penas, A. —2001— Syntaxonomical checklist of vascular plant communities of Spain and Portugal to association level — Itinera Geobot. 14: 5-341.

Rivas-Martínez, S., Díaz, T.E., Fernández-González, F., Izco, J., Loidi, J., Lousã, M. & Penas, A. —2002— Vascular plant communities of Spain and Portugal. Addenda to the syntaxonomical checklist of 2001 — Itinera Geobot. 15: 6-922.

Rivas-Martínez, S. & coautores. —2011— Mapa de series, geoseries y geopermaseries de vegetación de España. Parte II — Itinera Geobot. 18 (2): 425-800.

Taberlet, P., Fumagalli, L., Wust-Saucy, A.G. & Cosson, J.F. —1998— Comparative phylogeography and postglacial colonization routes in Europe — Mol. Ecol. 7: 453-464.

Tichý L. & Chytrý M. —2006— Statistical determination of diagnostic species for site groups of unequal size — J. Veg. Sci. 17: 809-818.

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APPENDIX (Tables S1-S6)

Numbers between parentheses (in localities) refer to a reference number database of authors.

Table S1(1)

Helianthemo cantabrici-Festucetum hystricis ass. nov.

(*Festucion burnatii*, *Festuco hystricis-Poetalia ligulatae*, *Festuco hystricis-Ononidetea striatae*)

Altitude (1=10m)	214	215	216	205	213	204	192	223	197	222	205	206	197	211	207	211	197	212
Area (m^2)	50	10	50	80	100	20	50	75	100	75	50	75	100	20	25	50	75	75
Cover (%)	20	60	-	20	-	-	100	40	40	70	40	40	60	50	50	-	60	70
Aspect	W	SW	N	SW	W	N	NW	SE	N	SE	SW	E	SE	SW	W	SW	SE	NE
Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Characteristics																		
Helianthemum canum subsp. *cantabricum*	1	3	3	2	2	1	2	3	2	3	2	2	2	2	3	2	3	3
Koeleria vallesiana	1	2	+	1	1	.	1	2	1	1	2	1	1	1	2	2	2	1
Carex sempervirens	1	+	1	+	1	2	2	2	+	+	1	2	2	+	1	2	2	2
Anthyllis vulneraria	+	1	1	1	1	2	1	1	+	3	+	1	2	.	2	1	3	1
Thymus praecox	1	+	2	.	+	2	.	1	+	1	1	1	.	.	.	1	2	1
Minuartia verna	1	+	+	.	.	2	+	.	+	.	+	1	.	1	+	+	1	1
Androsace villosa	.	+	.	+	.	1	+	2	.	1	+	1	+	1	1	1	2	2
Helictotrichon sedenense	1	1	1	+	+	1	2	+	+	.	.	.	.	.	+	.	1	1
Jurinea humilis	.	.	.	+	+	+	+	1	1	.	2	1	2	1	+	1	1	1
Dethawia splendens	.	.	1	+	1	.	+	+	.	2	1	2	1	+	+	1	+	+
Saxifraga conifera	.	1	1	.	.	.	.	.	.	1	1	1	1	2	+	1	1	+
Euphrasia salisburgensis	+	+	.	.	.	.	.	.	+	.	+	1	.	+	+	1	.	1
Festuca hystrix	.	.	.	.	.	.	.	+	2	.	+	.	.	.	.	.	.	+
Galium pyrenaicum	1	+	+	+	+	+	.	.	.	.	.	+	.	.	+	+	+	.
Arenaria purpurascens	1	1	1	.	1	1	.	.	.	.	.	.	.	1	+	.	+	1
Gypsophila repens	.	.	.	+	+	.	.	1	+	2	1	.	+	.	.	1	+	.
Silene acaulis	+	.	+	.	1	.	.	.	.	.	+	+	+	.	.	1	1	.
Pedicularis pyrenaica var. *fallax*	+	.	.	.	.	+	.	.	+	.	.	.	1	.	+	+	1	1
Globularia repens	2	.	.	+	+	.	.	.	.	.	.	.	.	+	1	1	.	+
Euphorbia chamaebuxus	+	.	+	+	.	.	+	+	+	+	.	+	.	.	.	.	.	+
Poa alpina	.	+	+	.	+	1	.	+	.	.	.	.	.	.	.	.	.	.
Silene ciliata	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	+
Alchemilla alpigena	.	.	.	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.
Plantago alpina	.	.	.	.	.	.	.	.	+	.	+	1	+	1	.	.	.	.
Gentianella campestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Festuca burnatii	+	1	1	+	.	+	1	.	.	.	.	.	.	.	.	.	.	.
Helianthemum urrielense	.	.	.	.	.	.	.	1	+	1	+	2	2	1	.	.	.	.

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Juniperus alpina	.	.	.	.	.	.	1	.	+	+	.	.	.	.	r	.	.	+
Viola rupestris	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.
Potentilla crantzii	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gentiana occidentalis	.	.	.	.	+	+	.	+	.	.	+	.	.	.	.	1	.	.
Sedum atratum	.	.	.	.	+	.	.	.	+	.	.	+	.	.	.	+	+	.
Eryngium bourgatii	.	.	.	.	.	1	1	1	+	.	.	.	+	+	.	.	.	+
Genista legionensis	.	.	.	.	.	.	4	1	+	.	.	.	.	.	.	.	.	.
Erigeron alpinus	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	1	.
Iberis carnosa	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.
Ranunculus carinthiacus	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Agrostis schleicheri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Astragalus depressus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hippocrepis comosa	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.
Draba dedeana	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Ranunculus parnassiifolius subsp. *favargeri*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.
Saxifraga oppositifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Carex humilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla nivalis subsp. *asturica*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Armeria cantabrica	.	+	.	.	.	1	.	.	.	.	.	.	1	+	.	.	.	.
Matthiola perennis	.	.	.	1	.	.	.	.	+	.	.	.	.	+	.	.	.	.
Minuartia villarii	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Sempervivum cantabricum	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+
Luzula pediformis	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	1
Gentiana verna	.	.	.	.	.	.	+	.	.	.	.	.	+	.	+	.	.	1
Sideritis hyssopifolia	.	.	.	.	.	.	+	1	.	.	+	.	.	1	.	.	.	.
Arenaria moehringioides	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Reseda glauca	.	.	.	+	+	.	1	.	.	.	.	.	.	.	.	.	.	.
Festuca rubra	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Festuca picoeuropeana	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Lotus corniculatus	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Saxifraga paniculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Arenaria erinacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Herniaria glabra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trinia glauca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table S1(2)

Helianthemo cantabrici-Festucetum hystricis ass. nov.

(*Festucion burnatii, Festuco hystricis-Poetalia ligulatae, Festuco hystricis-Ononidetea striatae*)

Altitude (1=10m)	213	215	195	202	195	199	201	239	222	228	236	225	202	209	182	205	200	187	
Area (m²)	75	75	75	75	75	75	30	100	50	100	100	100	100	50	100	100	10	20	
Cover (%)	60	65	60	40	50	80	70	30	60	30	20	40	60	70	70	50	-	-	
Aspect	E	E	W	W	W	W	N	N	W	S	N	NW	NW	N	NE	W	E	S	
Relevé number	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Syn.
Characteristics																			
Helianthemum canum subsp. *cantabricum*	2	3	1	3	3	2	2	2	2	2	2	1	2	2	2	1	1	.	V
Koeleria vallesiana	1	1	2	2	2	2	2	1	2	2	2	2	2	1	2	2	1	.	V
Carex sempervirens	3	2	+	+	.	1	1	+	1	+	+	1	3	3	+	+	.	.	V
Anthyllis vulneraria	1	1	1	2	2	1	1	1	1	2	1	+	.	.	.	1	.	.	V
Thymus praecox	1	1	1	+	2	1	1	1	1	+	+	1	.	1	+	1	.	.	IV
Minuartia verna	1	1	1	1	1	1	1	+	1	1	1	.	1	.	1	1	.	.	IV
Androsace villosa	2	2	1	1	1	2	.	1	1	+	+	.	.	.	+	1	.	.	IV
Helictotrichon sedenense	.	+	+	+	1	.	.	2	2	2	2	2	1	1	+	1	.	.	IV
Jurinea humilis	1	1	1	+	1	1	.	.	.	+	.	.	.	.	+	+	.	.	IV
Dethawia splendens	+	.	.	.	.	.	.	+	1	.	1	+	.	+	.	+	.	+	IV
Saxifraga conifera	+	1	.	.	.	.	3	+	1	+	+	+	+	+	.	.	.	.	III
Euphrasia salisburgensis	+	1	+	.	.	+	.	.	+	+	.	+	+	.	+	.	+	.	III
Festuca hystrix	.	.	3	3	4	3	3	.	2	1	1	1	+	.	+	1	2	1	III
Galium pyrenaicum	.	.	.	+	.	.	.	1	+	1	1	1	.	.	.	+	.	.	III
Arenaria purpurascens	+	1	.	.	.	.	1	.	1	.	.	+	+	+	.	+	.	.	III
Gypsophila repens	+	+	.	.	+	.	.	.	.	+	+	.	.	.	1	+	+	.	III
Silene acaulis	.	+	.	.	.	.	.	+	+	+	+	+	+	.	+	.	.	.	III
Pedicularis pyrenaica var. *fallax*	+	+	.	.	.	.	.	.	.	+	+	+	.	+	.	.	.	+	III
Globularia repens	.	.	.	+	.	.	.	+	.	+	1	+	.	.	+	1	2	.	III
Euphorbia chamaebuxus	.	.	+	+	.	.	.	.	+	.	+	.	.	+	.	.	.	.	II
Poa alpina	.	.	.	.	.	.	+	1	+	+	+	1	1	1	.	.	.	.	II
Silene ciliata	.	.	+	.	+	.	.	+	.	+	.	.	.	.	.	+	.	.	II
Alchemilla alpigena	+	+	.	.	.	.	.	.	+	.	+	+	+	.	.	.	+	.	II
Plantago alpina	.	.	.	.	.	1	.	.	+	.	1	.	.	+	.	.	.	+	II
Gentianella campestris	1	.	.	.	.	.	.	+	+	+	+	+	+	+	.	+	.	.	II
Festuca burnatii	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2	4	II
Helianthemum urrielense	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II

Relevé number	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Syn.
Juniperus alpina	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	II
Viola rupestris	.	+	.	.	.	.	.	.	.	.	1	+	+	.	+	.	.	.	II
Potentilla crantzii	.	.	.	.	.	2	.	.	.	+	+	+	.	1	1	.	.	.	I
Gentiana occidentalis	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	I
Sedum atratum	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	I
Eryngium bourgatii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Genista legionensis	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	I
Erigeron alpinus	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	I
Iberis carnosa	.	.	.	.	.	.	.	1	.	1	+	+	.	.	.	.	.	.	I
Ranunculus carinthiacus	.	.	.	.	.	.	.	+	+	.	.	+	+	.	.	.	.	2	I
Agrostis schleicheri	.	.	.	.	.	.	.	+	+	.	.	.	+	1	1	1	.	.	I
Astragalus depressus	.	.	.	.	.	.	.	+	+	.	.	+	+	.	+	.	.	+	I
Hippocrepis comosa	.	.	.	.	.	+	+	.	.	.	.	.	.	.	+	.	.	.	I
Draba dedeana	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	1	I
Ranunculus parnassiifolius subsp. *favargeri*	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	+	.	.	I
Saxifraga oppositifolia	.	.	.	.	.	.	.	.	+	.	+	.	.	+	.	+	.	.	I
Carex humilis	.	.	.	.	.	.	.	.	+	1	.	.	+	.	2	1	.	.	I
Potentilla nivalis subsp. *asturica*	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	I
Armeria cantabrica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Matthiola perennis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	I
Minuartia villarii	.	.	.	.	.	.	.	.	1	.	.	+	+	.	.	.	.	.	I
Sempervivum cantabricum	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	I
Luzula pediformis	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I
Gentiana verna	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Sideritis hyssopifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Arenaria moehringioides	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.	I
Reseda glauca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Festuca rubra	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I
Festuca picoeuropeana	.	.	.	.	.	.	.	.	+	.	.	.	.	1	.	.	.	.	I
Lotus corniculatus	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	I
Saxifraga paniculata	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Arenaria erinacea	.	1	+	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Herniaria glabra	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	I
Trinia glauca	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	I

Other species: *Asperula aristata* + in 1 and 34; *Sedum album* + in 2, 1 in 25; *Carex ornithopoda* + in 3 and 10; *Biscutella laevigata* + in 7 and 8; *Arctostaphylos uva-ursi* + in 7 and 18; *Glandora diffusa* + in 9 and 34; *Thesium pyrenaicum* + in 10 and 18; *Festuca glacialis* + in 12 and 26; *Allium fallax* + in 14(+), 1 in 36; *Paronychia*

kapela + in 18 and 30; *Scilla verna* + in 19 and 31; *Sempervivum giuseppii* + in 21 and 32; *Merendera montana* + in 24 and 25; *Erigeron uniflorus* + in 29 and 30; *Helianthemum croceum* + in 33 and 34; *Jasione cavanillesii* + in 1; *Silene nutans* + in 2; *Ranunculus bulbosus* + in 5; *Trifolium pratense* +, *Iris latifolia* 1 in 6; *Galium saxatile* and *Pimpinella siifolia* + in 7; *Teucrium pyrenaicum* + in 9; *Campanula scheuchzeri* + in 11; *Pritzelago alpina* 1 in 13; *Selinum pyrenaeum* + in 14; *Scabiosa columbaria* and *Hieracium pilosella* + in 14; *Sedum sediforme* + in 18; *Viola pyrenaica*, *Sesleria caerulea* and *Phyteuma orbiculare* + in 19; *Leontodon taraxacoides* + *Kobresia myosuroides* 1 in 20; *Seseli libanotis* + in 21; *Seseli montanum* + in 23; *Erodium glandulosum* + in 25; *Valeriana globulariifolia* + in 26; *Oxytropis neglecta* + in 29; *Festuca indigesta* 1 in 33; *Avenula pratensis* + in 36.

Localities: all relevés from Central Massif, except 1, 26-34 from Eastern Massif and 2-7, 14, 15, 25 from Western Massif. 1: Entorno del Alto del Hoyo Oscuro (64); 2: Altos del Verde (89); 3, 5: Climbing Collado de les Merines (12,11); 4: Near Hoyos de Argüeyes (96); 6: Vega Huerta, Rivas-Martínez & al. (1984): tb. 34, rel. 6 (5); 7: Hoyos del Caballo (92); 8: Near Hoyo de Los Campanarios (111); 9: Surroundings of Las Llombas de Aliseda (42); 10: Jou Tras el Picu (102); 11, 16: Entre el Jou de los Cabrones y el Jou de Cerredo (23,24); 12: Hoyo Grande Cimero (117); 13, 17, 22: Jou Sin Tierre (137,138,122); 14: Camino del Burro (87); 15: Between Llago Huerta and Cuetalbo (93); 18: De Torre de Llordes a la Vega de Liordes (175); 19: Surroundings of La Brecha de los Cazadores (127); 20: Between Llagu Bajero and Torre de Llordes (176); 21, 23: Hoyo Sin Tierra (124,128); 24: Between La Vueltona and Hoyo Sin Tierra (123), *holotypus ass.*; 25: La Pedriza Carbanal (85); 26: La Silla del Caballo Cimero (74); 27: Campos de Valdominguero (69); 28: Surroundings of Pico del Grajal de Arriba (72); 29: Pica del Jierru (71); 30: La Rasa de la Inagotable (73); 31: Traviesas del Grajal de Arriba (68); 32: Between La Collada de San Carlos and El Pico del Sagrado (63); 33: Western slope of Samelar peak (59); 34: Collada de San Carlos (62); 35: Eastern slope of Los Cuetos del Trave (36); 36: Near Peña Gustal (82).

Table S2(1)

Jasiono cavanillesii-Helictotrichetum sedenensis ass. nova

(*Festucion burnatii, Festuco hystricis-Poetalia ligulatae, Festuco hystricis-Ononidetea striatae*)

Altitude (1=10m)	219	218	226	224	222	233	214	199	210	211	209	209	222	216	236	214	231	232	232	232	229
Area (m^2)	50	100	20	75	75	75	25	20	100	100	100	75	75	75	75	75	50	100	100	75	25
Cover (%)	10	20	20	10	10	10	25	20	10	10	10	-	20	20	10	30	-	-	60	60	20
Aspect	SW	S	NE	SW	W	NW	N	N	W	NW	N	-	NE	SW	N	NE	NW	N	W	W	NE
Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Characteristics																					
Galium pyrenaicum	1	1	1	1	2	2	2	1	1	1	+	+	1	1	2	1	2	2	2	2	1
Helictotrichon sedenense	+	1	1	2	2	1	2	2	1	1	+	+	2	2	2	2	2	2	2	2	1
Saxifraga oppositifolia	1	1	+	.	+	+	.	+	+	.	1	1	2	1	1	.	1	1	1	1	1
Minuartia verna	.	+	.	1	1	.	+	+	1	1	+	+	+	+	1	1	+	+	.	.	+
Jasione cavanillesii	.	+	+	.	.	+	1	+	+	+	+	+	+	.	.	.	+	+	1	1	+
Silene ciliata	.	.	.	+	+	+	.	.	1	+	+	+	+	+	+	.	+	+	+	+	+
Helianthemum canum subsp. *cantabricum*	1	1	+	2	1	2	2	2	1	1	.	.	1	2	1	2	2	2	1	1	1
Iberis carnosa	+	+	+	+	+	.	+	.	+	+	.	.	.	.	.	+	+	+	1	1	.
Anthyllis vulneraria	+	+	+	.	.	+	+	1	.	+	.	.	2	2	2	2	2	2	.	.	1
Silene acaulis	.	.	.	+	.	+	+	+	+	1	.	.	.	.	+	.	+	+	.	.	1
Thymus praecox	1	.	.	+	+	1	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Androsace villosa	1	1	1	1	+	1	2	1	1	1	+	+	.	.	.	.	.	.	.	.	1
Potentilla nivalis subsp. *asturica*	+	1	+	1	.	.	.	.	+	.	.	.	.	.	.	.	+	+	+	+	1
Gypsophila repens	+	1	.	+	+	+	+	+	.	.	+	+	1	1	+	1	.	.	+	+	+
Ranunculus parnassiifolius subsp. *favargeri*	+	+	+	+	1	1	+	1	.	+	+	+	.	.	.	.	.	.	.	.	+
Carex sempervirens	+	+	.	.	.	.	+	+	.	+	+	+	.	.	.	.	.	.	.	.	.
Armeria cantabrica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.
Koeleria vallesiana	1	+	.	.	.	1	1	1	1	1	1	1	1	.	.	+	.	.	.	.	+
Salix breviserrata subsp. *fontqueri*	+	+	.	.	+	.	.	.	.	.	1	1	.	.	.	.	1	1	2	2	.
Festuca glacialis	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Dethawia splendens	.	+	.	.	.	+	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.
Arenaria purpurascens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Senecio boissieri	1	1	1	.	2	2	.	1	1	1	1	1	.	.	.	.	+	+	.	.	.
Globularia repens	2	1	+	+	+	.	.	.	.	.	+	+	+	+	.	.	+	+	.	.	1
Matthiola perennis	.	.	.	.	.	.	+	+	.	.	+	+	.	.	+	+	+	+	.	.	+
Arenaria moehringioides	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Poa alpina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Festuca hystrix	1	+	.	.	.	.	.	1	2	1	1	1	+	2	+	.	.	.	.	.	.
Euphrasia salisburgensis	+	.	.	.	.	.	.	+	.	+	.	.	+	+	.	+	1	1	.	.	.
Helianthemum urrielense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.
Kobresia myosuroides	.	.	.	.	.	.	.	+	.	.	.	.	1	.	+	.	.	.	.	.	.
Sedum atratum	.	.	.	.	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.	.	.
Saxifraga conifera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxytropis neglecta	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.
Alchemilla alpigena	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pedicularis pyrenaica var. *fallax*	.	.	.	.	.	+	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Reseda glauca	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	+
Draba dedeana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Carex ornithopoda	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pritzelago alpina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia chamaebuxus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Saxifraga paniculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Polygonum viviparum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.
Carex capillaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex parviflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Veronica alpina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table S2(2)

Jasiono cavanillesii-Helictotrichetum sedenensis ass. nova

(*Armerion cantabricae, Seslerietalia caeruleae, Festuco-Seslerietea*)

Altitude (1=10m)	226	212	234	226	228	245	245	234	230	235	233	229	229	197	241	250	246	225	245	247	236	
Area (m²)	100	50	75	100	100	100	75	75	50	75	75	75	100	50	75	75	75	75	75	75	75	
Cover (%)	40	50	10	20	20	20	-	-	20	20	20	80	80	30	20	10	10	10	10	20	30	
Aspect	SW	NW	N	E	SW	NE	NE	S	W	E	NW	N	N	NW	N	N	E	NE	W	N	NW	
Relevé number.	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	Syn.
Characteristics																						
Galium pyrenaicum	1	1	1	1	1	1	1	1	1	2	2	3	3	+	+	2	2	2	2	1	1	V
Helictotrichon sedenense	1	+	1	1	1	2	2	2	2	1	1	1	1	+	+	2	2	2	1	1	2	V
Saxifraga oppositifolia	1	.	.	+	1	+	+	+	1	1	.	1	1	+	1	2	1	+	+	2	1	V
Minuartia verna	+	+	+	1	+	1	1	1	1	1	+	1	1	+	.	1	1	+	1	+	.	V
Jasione cavanillesii	+	+	+	+	1	+	+	+	+	+	.	1	1	.	+	+	+	2	1	2	1	V
Silene ciliata	+	+	+	+	1	1	1	+	1	1	+	1	1	+	.	1	1	1	1	1	.	V
Helianthemum canum subsp. *cantabricum*	1	1	1	1	1	1	1	1	+	1	2	1	1	.	.	.	.	.	.	.	.	IV
Iberis carnosa	.	+	+	+	+	+	+	+	1	+	1	+	+	+	.	+	+	1	1	+	.	IV
Anthyllis vulneraria	1	1	+	1	1	1	1	1	2	2	2	2	2	.	.	.	1	.	.	+	+	IV
Silene acaulis	+	.	+	+	1	+	+	+	+	+	+	1	1	.	2	+	1	1	+	2	.	IV
Thymus praecox	.	1	+	1	1	+	+	1	1	2	1	.	.	1	1	.	+	+	1	+	+	III
Androsace villosa	.	+	+	1	1	.	.	1	+	.	.	1	1	.	.	+	.	.	+	.	.	III
Potentilla nivalis subsp. *asturica*	1	+	+	+	+	+	+	+	.	.	+	.	.	+	+	.	.	.	+	+	.	III
Gypsophila repens	.	+	.	+	.	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	III
Ranunculus parnassiifolius subsp. *favargeri*	+	.	+	1	1	.	.	.	.	.	+	2	2	1	.	.	2	.	.	.	.	III
Carex sempervirens	.	1	.	+	+	+	+	+	+	.	.	+	+	+	+	.	.	+	.	.	.	III
Armeria cantabrica	.	+	+	+	.	+	+	1	+	1	+	.	.	1	+	.	+	1	+	+	1	III
Koeleria vallesiana	.	+	.	.	.	+	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	III
Salix breviserrata subsp. *fontqueri*	1	2	2	1	1	.	.	+	.	.	.	1	1	1	.	.	.	.	.	.	.	III
Festuca glacialis	+	1	+	+	.	+	+	+	+	.	+	+	+	1	.	.	+	+	+	+	1	III
Dethawia splendens	.	1	+	+	2	.	.	.	+	.	.	1	1	1	.	.	+	1	.	+	.	III
Arenaria purpurascens	+	+	+	.	1	+	+	.	+	+	+	2	2	+	.	.	+	1	.	1	+	III
Senecio boissieri	.	.	.	+	.	.	.	.	+	.	.	3	3	.	.	.	.	.	.	.	.	II
Globularia repens	.	.	+	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	+	.	.	II
Matthiola perennis	+	.	.	.	.	+	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	II
Arenaria moehringioides	1	+	.	.	+	.	.	+	1	1	.	.	.	.	.	+	1	+	1	+	1	II
Poa alpina	+	1	.	.	+	+	+	+	.	.	.	.	.	.	.	+	.	+	.	+	1	II

Relevé number.	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	Syn.
Festuca hystrix	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	II
Euphrasia salisburgensis	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	II
Helianthemum urrielense	.	.	.	.	.	1	1	+	+	1	+	.	.	1	.	.	.	.	.	.	.	II
Kobresia myosuroides	1	.	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Sedum atratum	.	.	.	.	.	+	+	+	.	+	.	.	.	.	.	.	.	+	.	.	1	I
Saxifraga conifera	.	.	.	.	+	.	.	+	+	+	.	.	.	.	.	.	+	+	+	.	.	I
Oxytropis neglecta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	I
Alchemilla alpigena	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	.	.	.	.	+	.	I
Pedicularis pyrenaica var. *fallax*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Reseda glauca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Draba dedeana	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Carex ornithopoda	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Pritzelago alpina	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	I
Euphorbia chamaebuxus	.	.	.	.	.	.	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	I
Saxifraga paniculata	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I
Polygonum viviparum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Carex capillaris	.	.	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	I
Carex parviflora	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Veronica alpina	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I

Other species: *Oxytropis halleri* + in 6; *Gentiana verna* + in 7; *Sideritis hyssopifolia* + in 9; *Gentianella campestris* + in 10; *Arenaria serpyllifolia* + in 14; *Oreochloa confusa* + in 14; *Arenaria erinacea* 1 in 15; *Silene nutans* and *Festuca burnatii* + in 16; *Agrostis schleicheri* 1 in 23; *Arenaria grandiflora* + in 24; *Asperula hirta* + in 25; *Gentiana nivalis* + in 26; *Omalotheca hoppeana* + in 30; *Hieracium mixtum* and *Erigeron uniflorus* + in 31; *Festuca picoeuropeana* + in 41; *Veronica nummularia* 1 in 42.

Localities: all relevés from Central Massif, except 9 and 10 from Eastern Massif and 16 from Western Massif. 1, 2, 23: Between Garganta del Jou Sin Tierre and La Canal del Lebaniego (51,52,49); 3, 21, 22, 25, 26: Jou de Cerredo (29,33,39,30,34); 4, 5: Jou Tras el Picu (100,101); 6: Near Peña Castil (187), *holotypus ass*.; 7: Jou de los Boches (135); 8: Jou Sin Tierre (126); 9,10: Around the Alto del Hoyo Oscuro (66,65); 11: Around La Garganta del Jou Sin Tierre (54); 12: Picos de Europa (197); 13: Surroundings of Hoyo Bajero (144); 14: Between Mountain hut J.D.Úbeda and Torre de la Párdida (106); 15: Top of La Canal del Vidrio (110); 16: Los Moledizos (95); 17: Near Jou Negro (79); 18: Plains between Jou Negro and Cerredo (192); 19, 20: To Horcada de San Carlos (209,163); 24: From Pico Arenizas to Jou de los Boches (165); 27, 28: Aroud the Collada de La Canalona (58,195); 29: Horcados Rojos (194); 30, 42: Surroundings of Cabaña Veronica (57,148); 31, 32: From Collada Blanca to Hoyo Bajero (140,141); 33: Between Jou Negro and Jou de la Párdida (162); 34: Range between Jou Cerredo and Jou de los Cabrones (211); 35: Surroundings of Mountain hut J.D.Ubeda (47); 36: Near Torre Coello (151); 37: Santa Ana Coll (108); 38: From Torre de la Palanca to Hoyo Bajero (145); 39: From Collada Blanca to Hoyo Bajero (143); 40: From Torre de la Párdida to Jou Negro (169); 41: Near Torre de la Párdida (168).

Table S3

Ranunculo carinthiaco-Poetum alpinae ass. nova

(*Armerion cantabricae, Seslerietalia caeruleae, Festuco-Seslerietea*)

Altitude (1=10m)	208	204	196	214	197	202	202	197	213	203	209	228	203	217	207	214	214	210	211	221	203	205	
Area (m²)	50	25	0	10	100	10	10	10	75	75	75	50	75	75	10	15	100	20	50	50	20	50	
Cover (%)	30	50	40	40	70	-	60	-	80	90	100	95	90	100	100	100	90	100	95	70	100	90	
Aspect	S	NW	SE	E	NW	NE	NE	NW	SE	NW	E	W	NW	-	N	N	N	N	NW	NW	SE	NE	
Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Syn.
Characteristics																							
Armeria cantabrica	.	2	.	+	2	2	2	2	1	1	.	1	1	2	2	2	1	1	+	1	+	.	V
Plantago alpina	.	1	.	.	.	2	2	1	3	2	4	2	2	2	2	2	1	2	1	1	.	1	IV
Silene acaulis	.	+	.	3	3	3	3	1	1	1	.	+	3	2	2	2	3	2	2	2	.	.	IV
Ranunculus carinthiacus	.	.	+	.	+	1	.	.	1	2	1	1	.	1	2	1	1	1	1	1	1	2	IV
Poa alpina	.	.	.	.	.	+	+	.	2	2	1	1	1	2	2	1	1	1	1	1	1	1	IV
Alchemilla alpigena	.	+	.	.	3	1	1	+	.	.	+	+	.	2	2	+	+	1	1	1	1	.	IV
Thymus praecox	2	.	.	1	.	+	+	.	.	+	.	+	+	.	.	1	.	+	+	+	1	+	III
Carex sempervirens	.	.	.	.	1	2	2	+	+	1	.	.	.	.	.	+	1	+	3	2	+	1	III
Anthyllis vulneraria	.	1	2	3	.	+	.	.	1	1	.	.	.	1	1	1	+	.	1	+	.	.	III
Helianthemum urrielense	.	.	.	1	+	.	.	4	2	1	+	.	.	.	1	1	1	.	.	+	+	.	III
Carex parviflora	.	.	.	.	.	.	.	.	.	1	+	1	2	2	1	1	1	+	1	1	.	.	III
Trifolium thalii	.	+	.	.	.	.	.	.	.	3	.	+	.	.	+	+	+	.	+	1	2	2	III
Gentiana verna	.	.	.	1	1	+	+	1	+	+	+	.	.	.	1	.	.	.	.	.	.	1	III
Arenaria purpurascens	3	1	+	.	.	.	.	.	.	.	.	.	.	1	+	1	.	1	+	+	.	.	III
Pritzelago alpina	.	.	.	.	.	+	+	+	1	2	.	.	.	.	+	.	+	.	.	.	+	+	III
Festuca rubra	.	.	.	.	.	2	.	1	.	.	.	.	.	1	.	.	2	3	2	2	3	3	III
Saxifraga conifera	.	.	.	.	.	.	.	.	1	+	+	+	1	.	.	.	+	+	+	2	.	.	III
Phleum alpinum	.	2	.	.	.	.	.	.	.	.	.	.	.	+	1	.	+	1	.	+	+	+	II
Carex macrostylon	.	+	1	.	.	.	.	.	.	+	.	.	.	2	1	1	.	1	.	.	.	+	II
Luzula pediformis	.	.	.	.	.	.	+	.	.	.	.	.	.	1	+	1	+	1	.	+	.	.	II
Festuca nigrescens	.	.	+	.	.	.	2	.	2	2	1	.	.	.	3	.	.	.	.	.	.	.	II
Omalotheca hoppeana	.	.	.	.	.	.	.	.	.	1	.	+	1	+	1	1	.	.	.	.	.	.	II
Euphrasia salisburgensis	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	2	+	+	.	II
Dethawia splendens	+	.	.	.	1	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	II
Helictotrichon sedenense	2	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	+	1	.	.	II
Gentianella campestris	.	.	1	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	1	+	.	.	II
Festuca glacialis	.	.	.	.	1	.	.	.	.	1	+	3	1	.	.	.	.	.	.	.	.	.	II

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Syn.
Biscutella laevigata	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	.	.	I
Helianthemum canum subsp. *cantabricum*	.	1	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I
Botrychium lunaria	.	.	.	.	.	.	.	.	.	.	+	+	.	.	1	.	.	.	+	.	.	.	I
Erigeron uniflorus	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	+	.	.	.	+	+	.	I
Galium estebanii	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	1	1	I
Gentiana nivalis	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	+	.	.	.	I
Iberis carnosa	1	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Ranunculus parnassiifolius subsp. *favargeri*	3	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Merendera montana	.	1	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Silene ciliata	.	.	.	1	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	I
Sedum atratum	.	.	.	+	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	+	.	.	I
Nardus stricta	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Pedicularis pyrenaica var. *fallax*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	+	.	.	I
Euphorbia chamaebuxus	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I
Koeleria vallesiana	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I
Silene nutans	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Helianthemum croceum	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Sempervivum cantabricum	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I
Oxytropis neglecta	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Hippocrepis comosa	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
Galium saxatile	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Saxifraga oppositifolia	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Linaria alpina	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Soldanella alpina	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Hieracium pilosella	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	I
Acinos alpinus	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	I
Arenaria moehringioides	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	.	.	.	I
Arabis ciliata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	I
Lotus corniculatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	I

Other species: *Campanula rotundifolia* and *Campanula arvatica* +, *Sideritis hyssopifolia* and *Pimpinella siifolia* 1, *Crepis pygmaea* 2 in 1; *Digitalis parviflora, Festuca rivas-martinezii* and *Scabiosa columbaria* +, *Carex asturica, Potentilla neumanniana* and *Calluna vulgaris* 1 in 2; *Matthiola perennis, Iris latifolia, Crepis albida* and *Erodium glandulosum* +, *Androsace villosa* 1, *Jurinea humilis* 2, *Geranium subargenteum* 3 in 3; *Salix breviserrata s. fontqueri* r, *Galium pyrenaicum* 1 in 4; *Sesleria caerulea* and *Viola rupestris* +, *Carex ornithopoda* 1 in 5; *Carex humilis* + in 6; *Daphne laureola* + in 8; *Astragalus depressus* +, *Herniaria glabra* 1, *Ranunculus amplexicaulis* and *Draba cantabriae* 2 in 9; *Polygala edmundii* + in 10; *Lotus alpinus* and *Euphrasia hirtella* 1, *Carex pulicaris* 2 in 11; *Jasione laevis* + in 12; *Trifolium alpinum* 3 in 13; *Oxytropis foucaudii* + in 14; *Sedum album* + in 16; *Sagina nevadensis, Linaria supina, Pinguicula grandiflora* and *Veronica aphylla* + in 17; *Myosotis*

alpestris + in 18; *Allium schoenoprasum* + in 19; *Minuartia verna* + in 20; *Scilla verna*, *Conopodium pyrenaeum*, *Eryngium bourgatii*, *Vicia pyrenaica* and *Campanula scheuchzeri* + in 21; *Trifolium pratense* +, *Phyteuma orbiculare* 1 in 22.

Localities: all relevés from Central Massif, except 6-8 from Eastern Massif and 2, 12, 15-20 from Western Massif. 1: Collado Jermoso (199); 2: Muntain hut Llago Huerta (84); 3: Alto de la Begerina (83); 4, 9: Jou de los Boches (212,133); 5: Vega de Urriellu (203); 6, 7: Collado San Carlos (202,200); 8: Fuente La Escalera (198); 10: Near mountain hut Jou de los Cabrones (75) *holotypus ass.*; 11: Bajo Cuchalón de Villasobrada (112); 12: Horcada de Santa Maria (18); 13: Hoyo Grande Cimero (116); 14: Picos de Europa (94); 15: Torre Bermeja (90); 16: Altos del Verde (88); 17: Northern slope of Pico de los Asturianos (15); 18: Northeastern slope of Cumbre Cebolleda, Las Barrastrosa (16); 19: Jou Santo (41); 20: Surroundings of Torre de los Cabrones (43); 21, 22: Surroundings of mountain hut J.R. Lueje. Jou de los Cabrones (20,19).

Table S4(1)

Pediculari fallacis-Armerietum cantabricae Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

(*Armerion cantabricae, Seslerietalia caeruleae, Festuco-Seslerietea*)

Altitude (1=10m)	196	201	200	189	209	196	194	193	193	204	204	210	197	211	196	190	208	207	200	190
Area (m²)	75	75	30	30	75	75	75	75	75	50	75	75	25	75	100	100	75	75	50	100
Cover (%)	70	70	80	60	70	70	70	-	90	-	-	95	90	50	-	80	-	60	70	70
Aspect	E	E	N	W	S	W	W	SE	NW	E	NW	NE	NE	E	SE	NE	N	W	NW	NE
Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Characteristics																				
Carex sempervirens	+	+	.	.	3	4	4	.	3	3	3	4	2	2	3	3	4	4	3	3
Anthyllis vulneraria	1	1	1	1	2	1	1	1	1	1	1	1	+	1	1	1	1	1	.	+
Thymus praecox	1	2	1	2	2	.	1	2	2	1	1	1	.	1	1	.	1	1	+	+
Alchemilla alpigena	.	+	.	.	1	+	.	.	+	+	+	1	+	+	+	1	1	1	2	1
Arenaria purpurascens	2	1	.	+	.	.	1	.	+	1	1	1	+	.	.	.	2	2	1	2
Koeleria vallesiana	2	1	2	2	+	.	.	+	+	2	2	+	+	1	1	1	+	+	.	.
Poa alpina	1	1	.	1	.	1	.	+	.	1	1	1	.	.	.	.	1	1	1	1
Helianthemum urrielense	2	3	2	.	3	2	3	2	2	1	1	2	1	3	.	1	1	1	.	.
Dethawia splendens	+	+	.	.	+	1	1	1	1	.	.	.	1	+	.	+	1	1	2	1
Silene acaulis	+	.	+	.	.	.	.	.	+	.	.	1	.	+	2	1	1	1	1	.
Luzula pediformis	+	1	.	.	1	.	.	.	.	.	.	1	+	.	.	.	+	+	1	1
Armeria cantabrica	.	.	1	+	.	1	+	2	3	1	1	2	.	+	1	.	.	.	2	2
Minuartia verna	.	.	1	.	.	.	1	+	.	.	.	+	+	+	2	+	1	1	+	1
Saxifraga conifera	3	2	1	+	+	+	1	1	1	2	2	+	+	+	+	+	1	1	.	.
Androsace villosa	+	.	+	.	.	.	1	+	.	1	1	+	+	2	2	2	1	1	.	+
Helianthemum canum subsp. *cantabricum*	.	.	.	+	1	.	3	+	1	2	2	+	1	.	1	.	2	2	+	1
Plantago alpina	+	+	1	1	1	2	+	2	1	2	2	3	1	.	.	.	1	1	.	.
Festuca rubra	.	+	.	.	.	.	.	.	.	.	.	2	1	1	.	.	1	1	.	.
Euphrasia salisburgensis	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	+	1	1	.	.
Pedicularis pyrenaica var. *fallax*	.	.	.	.	.	.	.	.	.	.	.	+	+	.	1	+	1	1	1	1
Helictotrichon sedenense	1	1	.	.	1	.	1	1	+	.	.	.	.	.	+	.	.	.	1	.
Gentiana verna	.	.	+	+	.	+	.	.	1	.	.	.	.	.	.	.	.	.	1	.
Ranunculus carinthiacus	.	.	.	.	+	+	.	+	+	.	.	.	.	.	.	+	.	.	.	.
Sesleria caerulea	.	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	1	.	.	.
Polygonum viviparum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2
Silene ciliata	.	+	+	.	.	.	.	.	.	+	+	.	+	.	+	.	+	+	+	1
Gentianella campestris	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Biscutella laevigata	+	1	1	+	.	.	+	+	.	+	+	+	.	.	.	.	.	.	.	.
Euphorbia chamaebuxus	.	+	.	.	+	+	1	.	.	.	.	+	+	1	.	.	+	+	.	.
Sedum atratum	+	.	.	.	.	.	.	.	.	1	1	.	.	.	+	.	+	+	.	+
Gypsophila repens	.	.	.	.	+	.	.	.	.	1	1	+	1	1	.	+	+	+	.	.
Gentiana occidentalis	.	.	.	.	+	.	.	.	.	.	.	1	.	1	.	+	+	+	.	.
Scilla verna	+	.	.	.	1	1	.	.	1	.	.	1	.	.	+	+	.	.	.	.
Potentilla crantzii	.	.	.	+	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.
Sempervivum cantabricum	.	.	.	.	.	.	1	.	+	.	.	.	.	.	.	.	+	+	.	+
Phyteuma orbiculare	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+
Lotus corniculatus	.	+	.	.	.	+	.	1	1	.	.	1	.	.	.	.	.	.	.	.
Jurinea humilis	.	.	+	.	.	.	.	1	+	2	2	+	+	.	.	.	.	.	.	.
Paronychia kapela	+	+	2	.	+	+	+	.	.	+	+	.	.	.	.	.	.	.	.	.
Eryngium bourgatii	1	3	1	3	2	2	+	2	.	.	.	.	.	.	.	.	.	.	.	.
Pritzelago alpina	.	.	.	.	1	+	+	.	+	.	.	.	.	.	.	.	.	.	+	+
Carex humilis	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.
Agrostis schleicheri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	1	+
Saxifraga paniculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Leontodon taraxacoides	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Erigeron uniflorus	+	1	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Hippocrepis comosa	.	1	1	+	1	+	.	+	.	.	.	.	.	+	.	.	.	.	.	.
Arenaria moehringioides	.	.	1	.	.	.	.	.	.	1	1	+	.	+	1	+	.	.	.	.
Arenaria grandiflora	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Campanula arvatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.
Veronica aphylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Oxytropis halleri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Teucrium pyrenaicum	+	1	.	+	2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Matthiola perennis	.	.	.	.	.	+	+	.	.	1	1	.	.	.	+	.	.	.	.	.
Viola rupestris	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Sedum anglicum	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	+	+	.	.
Saxifraga oppositifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.
Myosotis alpestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viola riviniana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kobresia myosuroides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sideritis hyssopifolia	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hieracium pilosella	.	.	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus alpestris	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Linaria supina	.	.	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.
Draba cantabriae	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	+	.	.
Phyteuma spicatum	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.
Polygala edmundii	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.
Arenaria serpyllifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	1	1	.	.
Galium pyrenaicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Festuca glacialis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.
Primula integrifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Galium marchandii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acinos alpinus	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Merendera montana	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bromus erectus	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca nigrescens	.	.	.	.	.	1	.	1	2	.	.	.	.	.	.	.	.	.	.	.
Campanula scheuchzeri	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.
Iberis carnosa	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.
Conopodium pyrenaeum	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.
Festuca hystrix	.	.	.	.	.	.	.	+	+	.	.	.	.	1	.	.	.	.	.	.
Herniaria glabra	.	.	.	.	.	.	.	.	+	1	1	.	.	.	.	.	.	.	.	.
Festuca burnatii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.
Jasione cavanillesii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.
Anemone pavoniana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	1
Globularia repens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.
Androsace lactea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Bupleurum ranunculoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thesium pyrenaicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Selaginella selaginoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix breviserrata subsp. *fontqueri*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Botrychium lunaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium thalii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cruciata glabra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helianthemum croceum	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca gautieri	.	.	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxytropis neglecta	.	.	.	.	+	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Pimpinella siifolia	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arabis ciliata	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Draba dedeana	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Alyssum montanum	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus amplexicaulis	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.
Seseli nanum	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	+	.	.
Seseli montanum	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	.	.	.
Lotus alpinus	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Seseli libanotis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Avenula pratensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Potentilla nivalis subsp. *asturica*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.
Erigeron alpinus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.
Ranunculus thora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Rhinanthus minor	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pinguicula grandiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viola biflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arctostaphylos uva-ursi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Campanula rotundifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Omalotheca hoppeana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nardus stricta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thalictrum minus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table S4(2)

Pediculari fallacis-Armerietum cantabricae Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

(*Armerion cantabricae, Seslerietalia caeruleae, Festuco-Seslerietea*)

Altitude (1=10m)	222	224	210	198	206	193	203	221	196	205	209	200	204	219	215	211	205	211	213	
Area (m²)	30	50	30	50	50	10	75	75	75	75	75	75	75	75	75	75	75	75	75	
Cover (%)	-	-	-	70	70	100	100	90	80	80	95	100	90	100	90	70	90	90	90	
Aspect	NW	W	N	NE	N	N	N	N	NE	N	N	N	NW	NW	N	NW	NE	NE	NE	
Relevé number	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Syn.
Characteristics																				
Carex sempervirens	2	2	2	3	3	3	4	5	4	4	4	4	3	4	3	3	3	3	2	V
Anthyllis vulneraria	1	1	.	1	.	1	2	1	1	1	1	1	1	1	1	2	1	+	1	V
Thymus praecox	1	1	.	1	+	1	+	1	1	1	1	2	1	1	1	1	1	1	1	V
Alchemilla alpigena	3	2	2	1	+	1	1	1	2	2	2	3	2	1	1	1	.	1	1	V
Arenaria purpurascens	2	2	2	.	+	.	1	1	+	1	1	1	1	1	2	1	1	1	1	IV
Koeleria vallesiana	.	.	.	+	1	.	.	.	1	+	+	.	1	+	2	+	+	1	1	IV
Poa alpina	2	+	1	.	.	+	1	1	1	1	1	.	1	2	2	1	1	1	1	IV
Helianthemum urrielense	.	1	.	1	.	.	.	.	2	2	+	1	1	1	.	2	1	1	.	IV
Dethawia splendens	+	1	.	+	.	+	.	2	+	1	1	.	+	1	+	1	.	.	.	IV
Silene acaulis	.	1	2	1	2	+	1	1	1	1	+	1	+	.	1	1	1	.	1	IV
Luzula pediformis	2	2	1	.	.	1	1	1	+	+	+	1	+	+	1	1	+	1	.	IV
Armeria cantabrica	2	2	1	.	.	.	3	2	+	.	.	.	+	+	+	2	+	+	.	IV
Minuartia verna	1	1	1	.	.	+	.	.	.	+	+	+	+	+	+	.	+	+	+	IV
Saxifraga conifera	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	.	+	+	IV
Androsace villosa	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	1	+	+	+	IV
Helianthemum canum subsp. *cantabricum*	.	.	.	.	1	.	.	.	.	1	1	1	+	1	2	1	1	.	1	IV
Plantago alpina	.	.	1	.	.	.	.	+	1	1	.	1	+	.	.	.	.	1	+	III
Festuca rubra	+	1	.	1	.	1	2	1	2	1	1	1	2	1	1	1	+	2	.	III
Euphrasia salisburgensis	.	.	1	+	.	1	.	+	.	+	+	+	+	+	1	+	1	+	+	III
Pedicularis pyrenaica var. *fallax*	+	+	1	+	.	+	.	+	.	1	1	+	.	.	.	+	1	.	.	III
Helictotrichon sedenense	1	2	.	.	+	+	+	+	.	.	+	.	.	+	.	.	.	1	+	III
Gentiana verna	+	.	+	+	.	.	+	1	.	+	.	.	+	+	+	1	+	+	.	III
Ranunculus carinthiacus	.	.	.	+	+	+	.	1	1	+	+	+	+	+	+	.	.	.	+	III
Sesleria caerulea	.	.	.	.	.	.	3	2	2	2	2	2	2	1	3	2	2	2	1	III
Polygonum viviparum	1	.	1	+	+	.	1	.	1	1	1	1	.	1	1	1	1	1	.	III
Silene ciliata	.	.	+	.	.	.	1	1	.	.	.	.	.	+	1	.	.	.	.	II
Gentianella campestris	.	.	1	1	.	+	1	1	1	1	+	1	1	+	.	.	1	+	+	II

Relevé number	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Syn.
Biscutella laevigata	.	.	.	.	.	.	1	+	+	.	.	.	.	+	.	.	+	.	.	II
Euphorbia chamaebuxus	.	+	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	+	II
Sedum atratum	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	+	II
Gypsophila repens	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	+	.	.	.	II
Gentiana occidentalis	.	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	+	+	II
Scilla verna	.	.	.	.	.	1	.	.	.	+	.	+	.	.	.	.	.	.	.	II
Potentilla crantzii	.	1	.	.	.	.	+	.	.	+	.	1	+	.	.	.	.	+	+	II
Sempervivum cantabricum	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	+	II
Phyteuma orbiculare	.	.	.	.	.	.	.	.	.	1	+	+	1	1	1	.	.	.	1	II
Lotus corniculatus	.	.	.	.	.	1	.	.	.	.	.	1	1	.	.	.	.	.	+	II
Jurinea humilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	II
Paronychia kapela	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Eryngium bourgatii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Pritzelago alpina	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	II
Carex humilis	.	.	.	.	.	.	.	.	.	.	1	1	1	.	+	.	2	2	4	II
Agrostis schleicheri	1	+	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Saxifraga paniculata	+	.	.	+	+	.	.	.	.	+	+	.	.	.	.	.	+	+	.	II
Leontodon taraxacoides	.	.	.	.	.	.	.	+	.	.	.	+	.	.	1	.	+	.	.	I
Erigeron uniflorus	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	.	.	.	+	I
Hippocrepis comosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Arenaria moehringioides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Arenaria grandiflora	.	.	.	.	.	.	1	.	.	.	1	1	.	.	1	.	+	.	.	I
Campanula arvatica	2	.	.	.	.	.	.	.	.	.	.	.	+	.	.	1	.	.	.	I
Veronica aphylla	.	.	1	.	.	.	.	.	.	.	.	+	.	1	.	.	1	1	.	I
Oxytropis halleri	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	1	+	1	I
Teucrium pyrenaicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Matthiola perennis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Viola rupestris	.	.	.	+	+	.	.	.	1	.	.	.	.	.	.	.	.	1	.	I
Sedum anglicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Saxifraga oppositifolia	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
Myosotis alpestris	1	.	+	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	I
Viola riviniana	.	.	.	.	.	.	.	.	.	+	+	.	+	.	1	.	.	.	+	I
Kobresia myosuroides	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	+	2	2	I
Sideritis hyssopifolia	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
Hieracium pilosella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	I
Ranunculus alpestris	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I

Relevé number	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Syn.
Linaria supina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Draba cantabriae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Phyteuma spicatum	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	I
Polygala edmundii	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	I
Arenaria serpyllifolia	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Galium pyrenaicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	I
Festuca glacialis	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	I
Primula elatior	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	I
Galium marchandii	.	.	.	.	.	.	.	+	.	+	.	.	+	+	.	.	.	.	.	I
Acinos alpinus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Merendera montana	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
Bromus erectus	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Festuca nigrescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Campanula scheuchzeri	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Iberis carnosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Conopodium pyrenaeum	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Festuca hystrix	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Herniaria glabra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Festuca burnatii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Jasione cavanillesii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Anemone pavoniana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Globularia repens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I
Androsace lactea	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Bupleurum ranunculoides	.	.	+	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	I
Thesium pyrenaicum	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	I
Selaginella selaginoides	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	I
Salix breviserrata subsp. *fontqueri*	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	+	+	.	I
Botrychium lunaria	.	.	.	.	.	+	1	.	+	.	.	.	.	.	.	.	.	.	.	I
Trifolium thalii	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	1	I
Cruciata glabra	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	I
Helianthemum croceum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Festuca gautieri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Oxytropis neglecta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Pimpinella siifolia	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Arabis ciliata	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Draba dedeana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I

Relevé number	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Syn.
Alyssum montanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Ranunculus amplexicaulis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Seseli nanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Seseli montanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Lotus alpinus	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Seseli libanotis	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Avenula pratensis	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Potentilla nivalis subsp. *asturica*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Erigeron alpinus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Ranunculus thora	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Rhinanthus minor	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Pinguicula grandiflora	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Viola biflora	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Arctostaphylos uva-ursi	.	.	.	.	+	.	.	.	.	.	.	.	.	1	.	.	.	.	.	I
Campanula rotundifolia	.	.	.	.	.	1	.	.	.	.	.	.	.	+	.	.	.	.	.	I
Omalotheca hoppeana	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	I
Nardus stricta	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	I
Thalictrum minus	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	I

Other species: *Sedum sediforme* + in 2; *Daphne laureola* and *Leucanthemum gaudinii* + in 3; *Plantago lanceolata, Selinum pyrenaeum, Digitalis parviflora, Silene nutans, Iris latifolia* and *Geranium subargenteum* +, *Sedum album* and *Sanguisorba minor* 1 in 4; *Genista legionensis, Erodium glandulosum, Hieracium mixtum* and *Festuca picoeuropeana* + in 5; *Linum salsoloides* + in 7; *Gentiana nivalis* +, *Carex brevicollis* 3 in 8; *Leontodon hispidus* + in 10; *Ranunculus bulbosus* 1 in 12; *Scabiosa columbaria* + in 14; *Brachypodium rupestre* + in 19; *Festuca scoparia* +, *Euphorbia flavicoma* 1 in 21; *Carex parviflora* + in 22; *Cerastium arvense* + in 23; *Linum bienne* + in 24; *Galium estebanii, Aquilegia pyrenaica, Stachys alopecuros* and *Hypericum nummularium* + in 26; *Stellaria holostea, Helianthemum nummularium* and *Saxifraga granulata* +, *Rhinanthus angustifolius* 2 in 27; *Knautia arvensis* + in 29; *Trifolium pratense* + in 32; *Juniperus alpina* 1 in 34; *Sedum acre* 1 in 35; *Saxifraga aizoides* + in 36; *Vicia pyrenaica* + in 37.

Localities: all relevés from Central Massif, except 19, 21, 23 and 25 from Eastern Massif and 3 and 4 from Western Massif. 1, 2: From Torre de Llordes to Vega de Liordes (173,174); 3: Hoyos Cavaos (91); 4: Puertos de Cuba (86); 5: Jou Sin Tierre (136); 6-9: Hoyo Sin Tierra (129-132); 10, 11: Near mountain hut Jou de los Cabrones (76,189); 12: Surroundings of La Brecha de los Cazadores (150); 13: Eastern slope of Los Cuetos del Trave (38); 14: Between mountain hut J.D.Úbeda and Torre de la Párdida (105); 15: Torre Altaiz, Rivas-Martínez et al. (1984): tb. 34, rel. 7 (6); 16, 24, 29: Entorno del Refugio J.D.Ubeda (45,48,104); 17, 18: Towards the Jou del Agua (193,81); 19: El Jisu, Rivas-Martínez et al. (1984): tb. 34, rel. 4 (3); 20: Horcadina de Cobarrobres, Rivas-Martínez et al. (1984): tb. 34, rel. 2 (1); 21: Prao Cortés, Rivas-Martínez et al. (1984): tb. 34, rel. 13 (7); 22: Colladina de las Nieves, Rivas-Martínez et al. (1984): tb. 34, rel. 3 (2); 23: El Jisu, Rivas-Martínez et al. (1984): tb. 34, rel. 5 (4); 25: Entorno del Alto del Hoyo Oscuro (67); 26: Ladera este de Los Cuetos del Trave (37); 27: Tiro Pedavejo (172); 28: From Llagu Bajero to Torre de Llordes (177); 30, 32: From Cabeza de los Tortorios to Majada de las Moñas (184,183); 31, 35, 39: Cabeza de los Tortorios (181,179,180); 33: Cabeza de las Moñas (182); 34: Near Collado de las Moñetas (188); 36: From Llagu Bajero to Torre de Llordes (178); 37, 38: Majada del Carbonal (185,186).

Table S5(1)

Saxifrago coniferae-Helianthemetum urrielense ass. nova

(*Armerion cantabricae, Seslerietalia caeruleae, Festuco-Seslerietea*)

Altitude (1=10m)	217	208	222	207	213	206	197	203	203	213	216	227	209	236	235	223	235	231	226	234	231	222	216	222	233	227
Area (m²)	50	50	25	75	80	75	75	75	75	75	50	20	75	75	75	75	75	75	75	75	90	25	100	75	100	25
Cover (%)	-	70	90	70	80	60	70	-	70	60	70	80	60	80	40	60	65	50	70	30	90	50	30	70	60	60
Aspect	N	SE	NE	NE	E	NE	N	NW	NE	E	E	E	NW	SE	W	W	SW	SE	NW	E	E	N	N	NE	N	NE
Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Characteristics																										
Thymus praecox	1	+	1	.	1	+	1	1	1	1	1	1	1	2	+	1	1	1	1	2	2	+	1	1	+	1
Silene acaulis	2	2	2	1	+	1	1	1	1	.	3	3	2	.	.	2	2	+	3	1	1	2	1	2	1	.
Armeria cantabrica	.	1	+	1	+	1	1	1	1	1	+	1	.	1	1	1	2	2	2	1	1	1	1	2	+	1
Saxifraga conifera	1	2	1	1	1	1	1	+	+	+	.	+	2	+	.	1	1	3	+	.	+	.	1	.	1	1
Festuca glacialis	+	.	1	.	+	.	.	+	+	1	1	1	1	+	1	+	+	+	1	.	.	2	1	1	+	1
Anthyllis vulneraria	1	1	1	1	1	2	2	2	2	2	.	1	1	2	3	2	2	1	.	.	1	2	+	+	1	2
Helianthemum urrielense	1	2	2	2	2	2	3	2	2	2	1	1	2	3	3	3	3	3	3	2	2	.	.	.	.	1
Carex sempervirens	1	+	+	4	4	3	3	4	4	+	2	1	3	.	.	1	+	2	+	.	+	1	+	2	2	.
Minuartia verna	.	1	.	+	+	1	+	+	+	1	+	.	.	.	1	+	+	+	1	.	.	+	+	1	.	+
Arenaria purpurascens	.	.	1	1	.	1	+	1	1	+	1	1	.	1	2	2	2	2	2	2	2	.	+	1	+	+
Poa alpina	1	+	1	+	.	1	+	1	1	.	.	.	.	.	+	.	.	+	+	.	.	.	.	+	.	1
Plantago alpina	1	1	3	+	2	+	2	2	2	2	2	+	2	+	.	.	+	1	.	1	3	1	.	+	1	.
Alchemilla alpigena	.	+	+	1	1	+	1	1	1	.	1	1	+	.	.	+	.	+	.	.	.	2	+	+	1	.
Sedum atratum	.	+	.	+	.	.	.	+	+	.	+	.	+	.	.	+	+	+	.	.	.	+	+	.	+	+
Silene ciliata	+	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	1	1	.	1	.	+	+	+	+	+
Arenaria moehringioides	.	.	.	+	1	.	.	1	1	.	+	+	+	1	1	1	1	+	+	+	.	.	.	.	+	.
Omalotheca hoppeana	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.	.	1	+	1	.	.	.	.	.	+	.
Helictotrichon sedenense	+	1	.	1	+	+	+	.	.	.	.	.	.	.	.	.	.	+	.	2	1	.	.	+	.	+
Dethawia splendens	+	+	+	+	+	1	+	1	1	+	.	+	+	.	.	2	.	+	.	.	.	.	.	.	+	.
Galium pyrenaicum	+	+	.	.	.	.	.	.	.	.	.	.	.	1	1	+	.	.	.	2	.	1	+	+	1	.
Ranunculus carinthiacus	+	.	.	.	+	.	.	.	.	+	1	+	.	.	.	1	.	+	.	.	.	.	.	.	1	.
Helianthemum canum subsp. *cantabricum*	+	3	+	.	1	1	.	2	2	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	+
Euphrasia salisburgensis	+	.	1	1	+	+	.	+	+	.	.	.	.	.	.	1	.	1	+	+	.	.	.	.	.	.
Festuca picoeuropeana	.	+	3	.	+	.	+	.	.	+	+	1	.	.	+	+	.	.	.	.	.	.	.	+	+	.
Iberis carnosa	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	.	+	.	.	.	.	1	+	+	.
Jasione cavanillesii	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	+	.	.	.	+	+	.	.
Gentianella campestris	.	.	.	+	+	1	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	1	.

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Veronica nummularia	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Koeleria vallesiana	+	+	+	.	+	+	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Gentiana verna	+	+	+	.	+	+	.	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Saxifraga oppositifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	1	.	+	1	.	.	.
Salix breviserrata subsp. *fontqueri*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2	2	3	2	2
Carex ornithopoda	.	.	.	.	.	.	.	.	.	1	+	+	.	.	.	.	.	+	+	.	.	.	+	.	.	+
Erigeron uniflorus	.	.	+	.	+	.	.	1	1	.	.	.	.	.	.	+	+	1	.	+	.	.	.	+	+	.
Festuca rubra	.	.	.	.	.	1	.	1	1	.	1	.	.	.	.	.	.	.	.	.	3	.	.	+	+	.
Luzula pediformis	.	.	.	+	+	+	+	.	.	+	+	1	+	.	.	.	.	.	.	.	1	.	.	.	.	.
Ranunculus parnassiifolius subsp. *favargeri*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	.	.	.	.	+	.	.	.
Euphorbia chamaebuxus	+	.	.	.	.	+	.	.	.	.	+	.	.	+	+	1	.	+	.	.	.	.	.	.	.	.
Matthiola perennis	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pedicularis pyrenaica var. *fallax*	.	+	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Erigeron alpinus	.	.	.	.	.	+	+	.	.	+	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Viola rupestris	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.
Agrostis schleicheri	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Polygonum viviparum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	+	.	+	.
Biscutella laevigata	.	.	.	+	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Carex parviflora	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	.	+	.	.	.	+	+	.
Hieracium mixtum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+	.	.	.	.	.	.
Pritzelago alpina	.	+	.	1	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gypsophila repens	.	.	.	.	+	.	.	1	1	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Scilla verna	.	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla crantzii	.	.	+	.	.	.	1	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.
Botrychium lunaria	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	+
Paronychia kapela	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Androsace villosa	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium estebanii	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Campanula arvatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Veronica aphylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Arenaria grandiflora	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca nigrescens	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arenaria serpyllifolia	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Veronica alpina	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Draba dedeana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Poa minor	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table S5(2)

Saxifrago coniferae-Helianthemetum urrielensis ass. nova

(*Armerion cantabricae, Seslerietalia caeruleae, Festuco-Seslerietea*)

Altitude (1=10m)	230	231	214	233	221	217	214	220	224	220	196	203	225	223	227	219	203	236	204	204	203	212	205	212	196	
Area (m²)	20	16	75	75	75	75	50	75	50	20	75	25	25	25	25	75	50	75	50	75	100	100	100	100	100	
Cover (%)	70	45	70	40	50	40	-	50	70	40	-	50	40	40	-	40	70	40	70	-	80	80	60	80	70	
Aspect	NW	N	NW	N	E	NW	W	N	SE	NE	NW	W	NW	N	N	NW	NE	NW	NE	NE	NE	W	SW	E	NW	
Relevé number	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	Syn.
Characteristics																										
Thymus praecox	+	1	1	2	2	1	1	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	+	+	+	V
Silene acaulis	2	2	2	3	3	3	2	2	1	2	2	1	+	2	1	1	1	1	2	2	1	+	1	2	2	V
Armeria cantabrica	+	1	1	+	3	1	1	1	+	2	2	1	2	2	1	1	1	2	1	1	+	.	.	+	+	V
Saxifraga conifera	2	+	+	1	2	1	1	2	1	1	1	2	2	1	2	2	2	1	1	1	+	1	+	+	+	V
Festuca glacialis	1	1	+	1	3	2	+	+	.	2	2	2	2	2	1	1	+	2	1	1	+	+	+	.	1	V
Anthyllis vulneraria	2	2	2	1	1	+	.	2	1	2	2	1	1	.	1	1	2	2	.	.	.	+	+	.	+	V
Helianthemum urrielense	.	2	3	.	+	.	1	+	1	2	2	+	+	+	1	2	2	3	1	1	+	.	.	.	1	V
Carex sempervirens	.	+	.	.	.	3	1	3	3	+	+	.	.	.	+	+	+	+	2	2	1	2	2	3	2	IV
Minuartia verna	.	+	+	1	.	1	+	1	+	1	1	.	1	.	+	+	+	1	+	+	+	+	+	+	+	IV
Arenaria purpurascens	+	1	.	2	+	.	1	+	+	+	+	.	.	.	1	.	+	.	.	.	1	.	+	+	.	IV
Poa alpina	2	.	1	2	1	.	+	1	1	1	1	1	1	1	1	1	.	1	+	+	1	+	1	+	.	IV
Plantago alpina	.	.	1	+	.	+	1	.	.	.	.	.	.	.	.	1	1	+	.	.	+	.	+	+	+	IV
Alchemilla alpigena	.	.	.	1	.	1	+	+	.	.	.	+	.	.	+	.	+	.	1	1	+	1	+	1	1	IV
Sedum atratum	.	.	+	.	.	+	.	+	+	1	1	+	+	+	+	+	+	+	+	+	+	+	.	.	.	III
Silene ciliata	.	.	.	2	1	1	+	+	.	+	+	.	+	1	+	1	+	1	+	+	+	.	+	.	.	III
Arenaria moehringioides	.	.	+	.	+	1	+	+	.	.	.	.	1	.	+	.	+	.	+	+	+	+	+	.	+	III
Omalotheca hoppeana	.	+	.	.	.	+	+	.	.	2	2	+	+	+	1	+	1	.	+	+	+	.	+	+	+	III
Helictotrichon sedenense	.	.	2	4	.	1	+	1	2	.	.	1	+	+	.	+	.	.	.	.	.	.	.	.	.	III
Dethawia splendens	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	+	.	III
Galium pyrenaicum	1	+	+	1	1	.	.	.	.	+	+	+	1	+	.	.	.	.	.	.	.	.	1	.	.	III
Ranunculus carinthiacus	.	.	2	+	.	.	+	.	+	.	.	.	.	.	.	+	.	.	+	+	1	1	+	1	1	II
Helianthemum canum subsp. *cantabricum*	1	.	1	.	.	.	1	.	2	.	.	.	+	.	.	.	+	.	.	.	.	1	1	1	.	II
Euphrasia salisburgensis	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	+	+	+	+	II
Festuca picoeuropeana	.	.	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	+	+	+	.	+	.	.	II
Iberis carnosa	.	.	+	+	.	.	.	.	.	+	+	+	+	+	+	+	+	.	.	.	.	.	.	.	.	II
Jasione cavanillesii	.	+	1	.	2	+	.	+	.	+	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	II
Gentianella campestris	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	1	II

Relevé number	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	Syn.
Veronica nummularia	.	+	+	.	.	+	+	.	.	1	1	1	+	1	+	+	+	.	.	.	.	.	.	.	.	II
Koeleria vallesiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	1	.	+	II
Gentiana verna	.	.	+	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Saxifraga oppositifolia	1	.	.	.	.	+	.	.	.	+	+	1	.	.	.	+	.	.	+	+	.	.	+	.	.	II
Salix breviserrata subsp. *fontqueri*	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	+	.	II
Carex ornithopoda	1	.	1	.	.	.	+	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Erigeron uniflorus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	II
Festuca rubra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	1	.	+	.	.	II
Luzula pediformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Ranunculus parnassiifolius subsp. *favargeri*	.	+	+	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	I
Euphorbia chamaebuxus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I
Matthiola perennis	.	.	.	.	.	.	.	.	.	+	+	+	.	.	+	.	.	+	.	.	.	.	.	.	.	I
Pedicularis pyrenaica var. *fallax*	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	1	.	+	.	I
Erigeron alpinus	.	.	.	.	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I
Viola rupestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	+	+	.	.	I
Agrostis schleicheri	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	1	1	2	I
Polygonum viviparum	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	1	I
Biscutella laevigata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	I
Carex parviflora	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
Hieracium mixtum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Pritzelago alpina	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	I
Gypsophila repens	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I
Scilla verna	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	I
Potentilla crantzii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I
Botrychium lunaria	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Paronychia kapela	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	+	.	.	.	.	.	.	.	.	I
Androsace villosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	I
Galium estebanii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	I
Campanula arvatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	I
Veronica aphylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	I
Arenaria grandiflora	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Festuca nigrescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Arenaria serpyllifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Veronica alpina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	I
Draba dedeana	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I
Poa minor	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	1	.	.	.	.	.	.	.	.	I

Other species: *Festuca hystrix* + in 1 and 49; *Viola biflora* + in 3 and 11; *Lotus alpinus* 2 in 3, 1 in 21; *Viola pyrenaica* + in 6 and 7; *Thesium pyrenaicum* 1 in 17, + in 41; *Oxytropis neglecta* + in 18, 1 in 41; *Reseda glauca* + in 22 and 23; *Minuartia villarii* 1 in 25, + in 47; *Gentiana nivalis* + in 25 and 41; *Kobresia myosuroides* + in 26 and 48; *Festuca burnatii* + in 32 and 33; *Saxifraga hirsuta* 2 in 36 and 37; *Epilobium anagallidifolium, Myosotis alpestris, Helianthemum nummularium* and *Arabis alpina* + in 36 and 37; *Saxifraga paniculata* + in 45 and 50; *Allium schoenoprasum* and *Trifolium thalii* + in 2; *Sempervivum cantabricum* + in 3; *Phyteuma orbiculare* + in 7; *Hieracium pilosella* + in 10; *Lotus corniculatus* 1 in 11; *Oxytropis halleri* and *Carduus defloratus* 1 in 14(1); *Galium marchandii* + in 16; *Astragalus depressus* + in 17; *Asplenium viride* + in 19; *Ranunculus alpestris* + in 22; *Selaginella selaginoides* + in 25; *Viola riviniana* + in 29; *Campanula rotundifolia* + in 30; *Sedum anglicum* 1 in 31; *Sempervivum giuseppii* + in 33; *Linaria alpina* and *Arabis ciliata* + in 38; *Oxytropis foucaudii* + in 41; *Soldanella alpina, Carex macrostylon, Linaria supina, Saxifraga granulata* and *Herniaria glabra* +, *Sagina nevadensis* 1, *Horminum pyrenaicum* 2 in 47; *Gentiana occidentalis* + in 49.

Localities: all relevés from Central Massif, except 2, 25 and 35 from Western Massif and 47 and 49 from Eastern Massif. 1, 33, 40: Between the Jou de los Cabrones and the Jou de Cerredo (26,25,27); 2: Boca del Jou Santo (13); 3: Near Jorcada Arenera (80); 4, 13: Hoyo Grande Cimero (118,115); 5, 45, 46: Near Jou Sin Tierre (107,55,196); 6: Jou Sin Tierre (121); 7: Hoyo Sin Tierra (125); 8, 9: Near Mountain hut Jou de los Cabrones (190,77); 10: Above the Llago de las Moñetas to Santa Ana (113); 11: surroundings of La Brecha de los Cazadores (40); 12, 26, 39, 41: Jou de Cerredo (35,32,28,31); 14, 20, 21, 30: Surroundings of Cabaña Verónica (146,149,98,147); 15: From Torre de la Párdida to Jou Negro (170); 16: Near Torres Areneras (166); 17: Neverón de Urriello (167); 18: From Collada Blanca to Hoyo Bajero (139); 19: Jou de la Párdida (171); 22: Under the Diente de Urriellu (206); 23: Between La Garganta del Jou sin Tierre y la Canal del Lebaniego (50); 24: Jou Tras el Picu (103); 25: Climbing the Jierru peak (70); 27: Range between Jou Cerredo and Jou de los Cabrones (201); 28: Plains northern Jou Cerredo (205); 29: Jou de los Boches (134); 31: Near Jou Tras el Picu (99); 32: From Collada Blanca to Hoyo Grande (114); 34: Surroundings of Jou de los Boches (119); 35: Between la Torre de la Canal Parda y la Torre del Alba (14); 36: Trail to Jou de los Cabrones (78); 37: Jou del Agua (191); 38: Surroundings of Mountain hut J.R.Lueje. Jou de los Cabrones (21); 42: Surroundings of Hoyo Bajero (142), *holotypus ass*.; 43: Surroundings of the vernal pool near mountain hut J.R.Lueje, Jou de los Cabrones (22); 44: Top of La Canal del Vidrio (109); 47, 49: Western slope of Samelar peak (61,60); 48, 50: Surroundings of la Garganta del Jou Sin Tierre (53,56); 51: Surroundings of mountain hut J.D.Ubeda (46).

Table S6

Oxytropido pyrenaicae-Elynetum myosuroidis Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
(*Oxytropido-Elynion, Elynetalia myosuroidis, Carici rupestris-Kobresietea bellardii*)

Altitude (1=10m)	238	238	230	238	234	239	223	223	219	223	231	223	225	223	217	228	235	225	231	231	231	
Area (m^2)	25	75	20	75	75	20	75	60	75	10	100	75	75	75	75	75	20	25	75	100	70	
Cover (%)	80	80	80	80	60	-	50	60	70	-	-	70	70	95	100	90	-	-	70	70	70	
Aspect	NE	NE	NW	NW	E	SE	NE	W	N	W	NE	W	N	NE	E	SE	NW	W	W	W	W	
Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Syn.
Characteristics																						
Anthyllis vulneraria	2	2	2	+	1	+	1	2	1	2	2	3	3	2	2	3	.	+	3	3	3	V
Kobresia myosuroides	2	2	4	4	2	2	2	2	3	3	3	2	1	3	3	5	.	.	2	2	2	V
Arenaria purpurascens	1	1	.	1	2	1	.	1	1	1	1	+	+	1	1	1	+	+	2	2	2	V
Helictotrichon sedenense	+	+	1	2	+	+	1	1	1	1	+	2	2	1	1	.	2	.	1	1	1	V
Helianthemum canum subsp. *cantabricum*	+	+	1	.	2	2	1	2	1	2	2	2	3	1	.	+	1	+	2	2	2	V
Thymus praecox	1	1	+	1	+	.	.	.	+	2	+	+	1	1	1	1	1	1	+	+	+	V
Carex sempervirens	4	4	.	.	2	3	2	3	3	2	3	+	3	2	3	+	+	+	.	.	.	IV
Silene acaulis	2	2	3	3	3	2	2	2	2	1	2	+	.	+	1	.	+	+	.	.	.	IV
Armeria cantabrica	1	1	.	+	.	.	.	1	.	+	+	.	+	+	1	1	+	+	1	1	1	IV
Minuartia verna	+	+	.	.	+	+	+	1	+	1	1	+	.	.	.	+	.	.	+	+	+	IV
Poa alpina	.	.	1	.	+	.	.	+	1	.	.	1	+	1	2	1	1	1	1	1	1	IV
Galium pyrenaicum	+	+	+	+	+	+	.	.	.	.	+	+	.	.	.	.	+	.	2	2	2	III
Helianthemum urrielense	+	+	.	1	.	.	.	1	.	.	.	+	+	.	1	3	.	+	1	1	1	III
Silene ciliata	+	+	.	1	+	+	+	1	.	1	.	+	.	.	+	.	1	.	.	.	.	III
Androsace villosa	.	.	+	.	2	+	.	+	+	1	1	+	2	+	.	2	.	.	.	.	.	III
Oxytropis neglecta	.	.	.	+	.	+	+	.	.	1	1	2	+	2	1	1	+	.	.	.	.	III
Dethawia splendens	.	.	1	1	+	1	+	.	+	1	+	+	.	.	.	.	.	.	.	.	.	III
Carex ornithopoda	1	1	1	.	.	1	.	.	.	.	.	.	.	.	.	+	.	.	1	1	1	II
Gentiana verna	.	.	1	+	+	1	.	.	+	.	1	+	+	.	.	.	.	.	.	.	.	II
Euphrasia salisburgensis	.	.	1	.	.	.	1	+	.	+	+	.	.	.	.	.	.	.	+	+	+	II
Carex parviflora	.	.	.	1	1	+	.	.	.	1	+	+	.	+	.	+	.	.	.	.	.	II
Arenaria grandiflora	+	+	.	+	.	.	.	.	.	.	.	+	1	1	.	+	.	.	.	.	.	II
Ranunculus parnassiifolius subsp. *favargeri*	+	+	+	1	.	+	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	II
Koeleria vallesiana	.	.	.	.	.	.	1	+	1	1	.	2	2	+	.	.	.	.	.	.	.	II
Festuca glacialis	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	II
Salix breviserrata subsp. *fontqueri*	3	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	II
Sedum atratum	.	.	.	+	.	.	.	.	+	.	1	+	.	.	.	.	+	1	.	.	.	II
Alchemilla alpigena	.	.	.	.	.	.	.	.	.	1	+	.	+	+	+	.	1	.	.	.	.	II

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Syn.
Jasione cavanillesii	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	II
Festuca picoeuropeana	.	.	.	+	.	.	.	.	.	.	.	.	1	1	1	.	.	3	.	.	.	II
Saxifraga conifera	.	.	.	.	+	.	.	+	.	.	.	+	1	.	.	.	.	1	.	.	.	II
Euphorbia chamaebuxus	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	I
Seseli montanum	+	+	.	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.	.	.	.	I
Luzula pediformis	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	I
Draba dedeana	.	.	.	.	1	+	.	.	.	.	2	+	.	.	.	.	.	.	.	.	.	I
Sempervivum cantabricum	.	.	.	.	.	.	.	.	+	.	+	.	1	1	.	.	.	.	.	.	.	I
Erigeron uniflorus	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	+	.	.	.	.	.	I
Biscutella laevigata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	+	1	.	.	.	I
Carex capillaris	+	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Festuca hystrix	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Saxifraga paniculata	.	.	.	.	+	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	I
Saxifraga oppositifolia	.	.	.	.	1	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
Arenaria moehringioides	.	.	.	.	.	1	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Phyteuma orbiculare	.	.	.	.	.	.	.	.	.	+	.	.	+	1	.	.	.	.	.	.	.	I
Jurinea humilis	.	.	.	.	.	.	.	.	.	.	.	1	2	+	.	.	.	.	.	.	.	I
Festuca rivas-martinezii	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	I
Trifolium thalii	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	+	.	.	.	I
Plantago alpina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	1	.	.	.	I
Matthiola perennis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	I
Carex lepidocarpa	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Pinguicula grandiflora	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Festuca burnatii	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Gentianella campestris	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Asplenium viride	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Sesleria caerulea	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Polygonum viviparum	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Euphrasia hirtella	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I
Potentilla crantzii	.	.	.	.	+	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	I
Poa minor	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Agrostis schleicheri	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	I
Pedicularis pyrenaica var. *fallax*	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	I
Ranunculus alpestris	.	.	.	.	.	.	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	I
Erigeron alpinus	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	I
Paronychia kapela	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	I
Carduus defloratus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	I

Other species: *Euphrasia minima* + in 4; *Geum pyrenaicum* and *Campanula arvatica* + in 6; *Campanula rotundifolia* and *Iberis carnosa* + in 9; *Festuca ovina* 1 in 10; *Gentianella ciliate*, *Botrychium lunaria* and *Solidago virgaurea* +, *Draba cantabriae* and *Veronica aphylla* 1 in 14; *Ranunculus carinthiacus*, *Polygonum aviculare* and *Phleum alpinum* +, *Galium mollugo* 1 in 15; *Eryngium bourgatii* and *Taraxacum officinale* + in 16; *Hippocrepis comosa* and *Galium estebanii* + in 18.
Localities: all relevés from Central Massif, except 17, 18 from Western Massif. 1: Climbing down to Jou Grande (208); 2: From Torre de la Palanca to Hoyo Bajero (159); 3: Horcadina del Jou Cerredo (210); 4: Near Collada Blanca (160); 5, 7, 11: Surroundings of Cabaña Verónica, rel. 11: Rivas-Martínez et al. (1984), tb. 1, rel. 2 (97,152,9); 6: From La Collada Blanca to Tirollago, Rivas-Martínez et al. (1984): tb. 1, rel. 3 (10); 8: Surroundings of Jou de los Boches (120); 9: Trail from Llago Cimero to Collado Jermoso (157); 10, 12-14: Colladina de las Nieves, rel. 10: Rivas-Martínez et al. (1984): tb. 4, inv. 1 (8,156,155,154); 15: Surroundings of Hoyo Bajero (158); 16: From Pico Arenizas to Jou de los Boches (161); 17: Horcada de Santa Maria (17); 18: Surroundings of La Torre de los Cabrones (44); 19, 21: From Torre de la Párdida to Jou Negro (164,153); 20: Jou del Cerredo (213).