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*in*

Porqueddu C. (ed.), Ríos S. (ed.).  
The contributions of grasslands to the conservation of Mediterranean biodiversity

Zaragoza : CIHEAM / CIBIO / FAO / SEEP  
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 92

2010  
pages 257-260

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=801252>

To cite this article / Pour citer cet article

Chocarro C., Juarez A., Barrantes O., Reiné R. **Floristic diversity in semi-natural mountain grasslands included in the Natural Habitat Types of Community Interest.** In : Porqueddu C. (ed.), Ríos S. (ed.). *The contributions of grasslands to the conservation of Mediterranean biodiversity.* Zaragoza : CIHEAM / CIBIO / FAO / SEEP, 2010. p. 257-260 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 92)



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# Floristic diversity in semi-natural mountain grasslands included in the Natural Habitat Types of Community Interest

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**Abstract.** The aim of this work is to evaluate the current situation of the flora and forage production in Pyrenean hay meadows, included in the Natural Habitat Types of Community Interest (NHTCI). 104 phytosociological relevés have been recorded at 4 Huesca Pyrenean valleys, located between 900 and 1700 m a.s.l. Species appearance (percentage of biological forms and Ellenberg values) and structural variables (agronomical families, height grass and production) were measured. Also, specific richness, Shannon and Evenness indices were calculated. A total of 183 species from 34 families were founded. Presence/absence data were analysed with TWINSpan. As a result, nine grassland groups were identified. Four alliances, *Arrhenatherion elatioris*, *Trisetum-Polygonum bistortae*, *Bromion erecti* and *Cynosurion cristati*, were recognized. The three firsts are included in the NHTCI. In addition, environmental variables were compared with ANOVA test. The results show significant differences between the groups obtained by TWINSpan for most of the variables. These sustainably managed grasslands have acceptable average productions (ca. 4300 kg DM/ha/year) and keep remarkable species richness values (33 species/plot) and Shannon diversity index ( $H' = 2.55$ ).

**Keywords.** Meadows – Pyrenees – Floristic composition – Biodiversity.

## **Diversité floristique dans les prairies de fauche de montagne comprises dans les Types d'Habitats Naturels d'Intérêt Communautaire**

**Résumé.** L'objectif de l'étude est d'évaluer la situation de la composition floristique et de la production des prairies de fauche des Pyrénées qui sont comprises dans les Habitats Naturels d'Intérêt Communautaire. Dans l'été de 2008 on a fait 145 relevés floristiques dans 4 vallées des Pyrénées de Huesca situées entre 900 et 1700 mètres. Nous avons enregistré chacune des variables physiologiques (% formes biologiques et les index de Ellenberg) et structurels (% groupes agronomiques, hauteur de l'herbe et production), on a également calculé la richesse des espèces, et les indices de Shannon et d'Evenness. Nous avons identifié un total de 183 espèces appartenant à 34 familles. À partir des données de présence/absence des espèces, l'analyse TWINSpan a été appliquée déterminant 9 groupes de prairies différents. Nous avons reconnu 4 alliances existantes (*Arrhenatherion elatioris*, *Trisetum-Polygonum bistortae*, *Bromion erecti* et *Cynosurion cristati*), les trois premiers étant d'intérêt communautaire. D'autre part, on a comparé, par analyse de variance, les variables d'environnement. Les résultats montrent des différences significatives entre les groupes obtenus par TWINSpan pour la plupart des variables. En général, les prairies de fauche des Pyrénées sont utilisées de façon durable, ce qui démontre le maintien de la production fourragère (4300 kg MS/ha/année) et la préservation de valeurs importantes pour la richesse des espèces (33 espèces/plot) et la diversité de Shannon ( $H' = 2,55$ ).

**Mots-clés.** Prairies – Pyrénées – Composition floristique – Biodiversité.

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## **I – Introduction**

Agricultural intensive practises have harmed nature in general and plant diversity in particular. It has almost eradicated wild plants and numerous rare habitats have been destroyed. Many

semi-natural habitats are also threatened both by further intensification of agriculture and by abandonment. Among the semi-natural habitats that have been particularly affected by these changes, meadows on moderately fertile soils have been founded, and the area covered by this kind of meadows has dramatically declined in Europe (Waesch and Becker, 2009).

Mountain hay meadows communities constitute a very important biodiversity reservoir, mainly due to the establishment of an environmental gradient as well as to management practises, which have been conducted for centuries in these areas. In the last 100 years land use changes in Europe have affected these communities (McDonald *et al.*, 2000). *Arrhenatherion elatioris* and *Trisetion polygonion* meadows are an example of such threatened habitats, that are becoming rare in central Europe due to the intensification in agriculture and abandonment. These alliances are included in the Natura 2000 habitat (6510 and 6520 codes). It is necessary to improve our knowledge about floristic characteristics of each of these habitats to ensure appropriate conservation management, with the requirements defined in Directive 92/43/EEC on the "Convention of Natural Habitats and of Wild Fauna and Flora", that is the main legal instrument for nature conservation in the European Union.

The aim of this work is to evaluate the current situation of the flora and forage production in the Pyrenean hay meadows included in the NHTCI.

## II – Materials and methods

During summer of 2008, before the first cut for hay forage, a total of 104 relevés were performed in 4 valleys of the Huesca Pyrenees: Tena, Broto, Gistain and Benasque. Meadows were selected based on their floristic and management representativeness within each valley. They are located between 900 and 1700 m a.s.l., both in slopes and valley bottoms.

Sampling consisted of a floristic inventory of the central 100 m<sup>2</sup> of each plot following the sigmatic method. Altitude, orientation, slope, maximum and average height of the meadow grass were scored. One sample of biomass within a quadrat of 0.25 m<sup>2</sup> per plot was collected for production estimation. Phytosociological classification of each plot was carried out with VEGANA program (de Cáceres *et al.*, 2003). Using PLANTATT database (Hill *et al.*, 2004), all Ellenberg indices and biological forms, according to Raunkiaer's life-forms classification (phanerophytes, chamaephytes, hemicryptophytes, geophytes and therophytes) were assigned for each species. TWINSpan analysis (Hill, 1979) was conducted with presence-absence data of species, in order to establish a plot classification according to their floristic composition. Grasses, legumes and forbs coverages, floristic richness, Shannon information index (H') and Evenness index (J) were calculated with cover values of species (Van der Maarel, 1979). Their values were compared with ANOVA analysis.

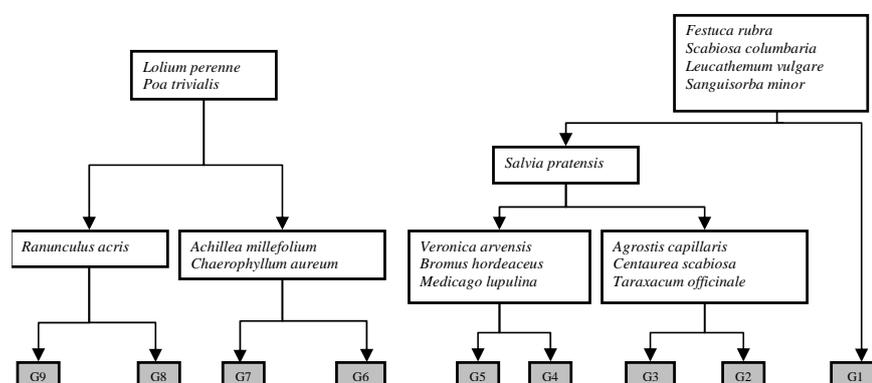
## III – Results and discussion

A total of 182 species (29 grasses, 23 legumes and 130 forbs) were identified. Four phytosociological alliances were detected, being *Al. Arrhenatherion elatioris* the most frequent (Table 1). The three communities: *Arrhenatherion elatioris*, *Trisetio-Polygonion bistortae* and *Bromion erecti*, are considered NHTCI according to directive 97/62/CE.

TWINSpan analysis classified the whole plots in 9 grassland types according to their floristic composition (Fig. 1). Table 1 resumes all communities present in each of the 9 grassland types. Most of them were included in *Arrhenatherion* alliance (Habitat 6510). In this group, the dominant association was *Ophioglosso-Arrhenatheretum elatioris*, which was the most important in G1 and G9 groups (80% in both of them). 22% of meadows were classified in *Al. Trisetio-Polygonion* (Habitat 6520). 5% of meadows were included in *Bromion* alliance (Habitat 6210). The last is considered as a transition to mountain pastures in the Pyrenees, despite they are cutted.

**Table 1. Phytosociological classification by presence/absence data of the TWINPAN's 9 grassland types classification (G1 to G9)**

Phytosociological classification	G1	G2	G3	G4	G5	G6	G7	G8	G9
<b>Al. Arrhenatherion elatioris</b>	100	44	65	82	40	27	100	92	100
<i>Ophioglosso-Arrhenatheretum elatioris</i>	80	11	35	27	0	13	27	58	80
<i>Rhinantho mediterranei-Trisetum flavescens</i>	20	22	15	45	40	7	32	0	0
<i>Gentiano luteae-Trisetum flavescens</i>	0	11	10	0	0	0	0	0	0
<i>Tragopogon-Lolietum multiflori</i>	0	0	5	9	0	7	41	33	20
<b>Al. Trisetum-Polygonion bistortae</b>	0	44	30	9	0	73	0	8	0
<i>Trisetum flavescens-Heracleetum pyrenaici</i>	0	44	30	9	0	73	0	8	0
<b>Al. Bromion erecti</b>	0	0	5	9	60	0	0	0	0
<i>Euphrasio Plantaginetum</i>	0	0	0	9	60	0	0	0	0
<i>Phyteumo orbicularis-Festucetum nigrescentis</i>	0	0	5	0	0	0	0	0	0
<b>Al. Cynosurion cristati</b>	0	11	0	0	0	0	0	0	0
<i>Cynosuro cristati-Trifolietum repentis</i>	0	11	0	0	0	0	0	0	0



**Fig. 1. Dendrogram with TWINPAN results. 9 groups classification of 104 relevés on Pyrenean meadows (1<sup>st</sup> cut) and indicator species for each groups.**

G1-5 types: meadows with lower production but higher species richness (Table 2). They showed the lowest grasses coverage and the highest coverage of forbs. Grass height was significantly lower than in other groups. These relevés were located generally at higher altitudes and slopes than the rest (Table 2). Floristic composition of these grasslands included species that preferred shaded, dry and more or less infertile sites. *Salvia pratensis* is a good indicator species of these conditions.

G6-9 types: meadows with higher production but significantly lower floristic richness. They contain the highest grass coverage and the lowest forb cover. Grass height of these groups is the highest of the whole groups. They are located at lower altitudes and lower slopes. Floristic composition consists of more exigent species in light, moisture and Nitrogen. *Poa trivialis*, *Ranunculus acris*, *Achillea millefolium* and *Chaerophyllum aureum* are characteristic species of these meadows.

Phytosociological classification of meadows does not reflect internal variability in the measured variables in different grassland types established by TWINSPAN. This meadows classification

can be complemented from biodiversity and production points of view by means of the analysis that has been performed in this study and it can be implemented as a useful tool for a more sustainable management.

**Table 2. Characteristic means of TWINPAN's 9 grassland types classification (G1 to G9). Results from the ANOVA analysis**

	G1 N=5	G2 N=9	G3 N=20	G4 N=11	G5 N=5	G6 N=15	G7 N=22	G8 N=12	G9 N=5	Sig.
Altitude m a.s.l.	1504	1496	1380	1322	1296	1244	1249	1326	1312	*
Biomass kg DM ha <sup>-1</sup>	3032	3696	4121	3756	4072	4586	4339	5192	6576	***
Species richness	39.4	37.3	40.6	36.6	33.8	31.3	27.8	23.5	25.0	***
Shannon index (H')	2.4	2.7	2.8	2.6	2.4	2.6	2.4	2.2	2.3	***
Evenness index (J)	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	***
Grasses cover %	32.1	38.2	40.4	40.4	31.7	42.8	50.0	54.1	58.7	***
Legumes cover %	14.1	16.2	16.6	20.8	25.6	14.3	21.8	20.0	18.1	ns
Forbs cover %	53.7	45.5	42.9	38.8	42.6	42.8	28.1	25.7	23.1	***
Ellenberg index L	2.29	2.79	2.55	2.88	3.00	3.27	3.56	4.49	3.99	***
Ellenberg index F	2.25	2.92	2.69	2.91	2.87	3.42	3.72	4.50	4.33	***
Ellenberg index R	2.47	2.83	2.60	2.93	3.12	3.36	3.66	4.72	4.22	***
Ellenberg index N	2.33	2.91	2.74	2.91	2.84	3.58	3.79	4.85	4.74	***
Ellenberg index S	0.08	0.25	0.18	0.27	0.30	0.14	0.17	0.12	0.09	***

## IV – Conclusions

Most of the Huesca Pyrenean mountain meadows correspond to *Arrhenatherion elatioris* and *Trisetum-Polygonum bistortae*. There was also representation of *Bromion erecti*. These groups are included in NHTCI. Groups included within a phytosociological alliance show differences in species appearance and structural variables, demonstrating that these alliances contain groups with high variability between them. These differentiating variables within phytosociological alliances should be taken into account for elaborating protection and conservation policies.

## Acknowledgements

It is acknowledged the financial support from the Government of Aragon (Project PM076/2007).

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