

This article was downloaded by: [151.24.57.134]

On: 30 September 2013, At: 02:02

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK

Plant Biosystems - An International Journal Dealing with all Aspects of Plant Biology: Official Journal of the Societa Botanica Italiana

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/tplb20>

Are all pastures eligible for conservation? A phytosociological survey of the Sardinian-Corsican Province as a basic tool for the Habitats Directive

E. Farris ^a, Z. Secchi ^a, L. Rosati ^b & R. Filigheddu ^a

^a Dipartimento di Scienze della Natura e del Territorio, Università di Sassari, Italy

^b Scuola di Scienze Agrarie, Forestali, Alimentari e Ambientali, Università della Basilicata, Italy

Accepted author version posted online: 22 Feb 2013. Published online: 02 Apr 2013.

To cite this article: E. Farris , Z. Secchi , L. Rosati & R. Filigheddu , Plant Biosystems - An International Journal Dealing with all Aspects of Plant Biology (2013): Are all pastures eligible for conservation? A phytosociological survey of the Sardinian-Corsican Province as a basic tool for the Habitats Directive, Plant Biosystems - An International Journal Dealing with all Aspects of Plant Biology: Official Journal of the Societa Botanica Italiana, DOI: 10.1080/11263504.2013.778911

To link to this article: <http://dx.doi.org/10.1080/11263504.2013.778911>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

Are all pastures eligible for conservation? A phytosociological survey of the Sardinian–Corsican Province as a basic tool for the Habitats Directive

E. FARRIS^{1*}, Z. SECCHI¹, L. ROSATI², & R. FILIGHEDDU¹

¹Dipartimento di Scienze della Natura e del Territorio, Università di Sassari, Italy and ²Scuola di Scienze Agrarie, Forestali, Alimentari e Ambientali, Università della Basilicata, Italy

Abstract

A consistent vegetation classification is an essential tool for conservation and monitoring purposes, also for semi-natural habitats such as pastures and hay meadows that are linked to traditional land use and generally considered crucial to maintain biodiversity within agricultural systems. Indeed, these habitats can be strongly affected by land abandonment or agriculture intensification. Despite their importance in the framework of the EU Habitats Directive (43/92/EEC), information on distribution, species composition, and conservation status is still lacking for many regions. To fill these gaps, we investigated from a phytosociological point of view the sheep pastures of the North-Western Sardinian trachy-basaltic sector. Three main communities were described as new: (i) perennial montane (meso-supratemperate) cattle and sheep pastures (*Loto alpini-Festucetum morisiana*); (ii) mixed (annual and perennial) Mediterranean (lower Thermomediterranean to lower supratemperate) sheep pastures (*Ornithogalo corsici-Poetum bulbosae*); and (iii) annual ploughed subnitrophilous Mediterranean and Temperate pastures (*Cynosuro polybracteati-Vulpium ligusticae*). As the first two host numerous endemic taxa and show a peculiar floristic composition, we assign them a higher conservation value, testified also by their classification in two new syntaxa: *Danthonio decumbentis-Caricion insularis* (*Molinio-Arrhenatheretea*) and *Ornithogalo corsici-Trifolienion subterranei* (*Poetea bulbosae*), respectively.

Keywords: Biodiversity conservation, Habitats Directive, Mediterranean grassland, northern Sardinia, phytosociology

Introduction

Pastures are often man-made grasslands of which the stability and productivity largely depend on the amount of species diversity (Sanderson et al. 2004; Clergue et al. 2005). Moreover, structure and species assemblages reflect environmental factors and management practices (Muller 2002; Blasi et al. 2009). These habitats can be strongly affected by changes in management practices such as land abandonment or agricultural intensification (Stoate et al. 2001; Dullinger et al. 2003; Stewart & Pullin 2008). Presently, there is increasing evidence that maintaining low levels of grazing livestock is essential to preserve plant species and habitats linked to pastures. Things that are detrimental include decreasing the amount of shepherding, land abandonment, and the

cessation of grazing (Farris et al. 2010; Janišová et al. 2011; Vassilev et al. 2011).

The Habitats Directive (43/92/EEC) aims to protect habitats and species that are considered crucial for the conservation of the biodiversity within the European Union (EU). Since 28 out of 198 habitat types listed in the Annex I of the Habitats Directive are under threat due to the cessation of traditional, low-intensity agricultural practices (Ostermann 1998), several nature conservation programs (Kleijn & Sutherland 2003; Nentwig 2003; Primdahl et al. 2003) are trying to maintain these semi-natural habitats linked to traditional management methods (Myklestad & Sætersdal 2004; Koocheki & Gliessman 2005). Consequently, these habitats should be well known under the structural, compositional, and functional

Correspondence: E. Farris, Dipartimento di Scienze della Natura e del Territorio, Università degli Studi di Sassari, via Piandanna 4, I-07100 Sassari, Italy. Tel: + 39 079 228675. Fax: + 39 079 233600. Email: emfa@uniss.it

aspects. Unfortunately, the information that many European habitats have on distribution, species composition, and conservation status is lacking (Ejrnaes et al. 2004).

In this paper, we aimed to evaluate which plant communities linked to ovine grazing are eligible for conservation within the framework of the EU Habitats Directive, and consider the North-Western Sardinian area (Italy) as a case study. Specific goals were (i) to identify and characterize these plant communities from an ecological and chorological point of view; (ii) to compare their floristic composition and species richness in order to evaluate their conservation value; and (iii) to discuss the appropriateness of their inclusion in the EU Habitats Directive.

Materials and methods

Study area

According to Arrigoni (1983a), the study area coincides with the trachy-basalt biogeographic sub-district of NW Sardinia (Figure 1), including the subregions of Logudoro, Mejlogu, Planargia, Campeda, Marghine, and Goceano. The substrata may be ascribed mainly to two vast complexes: the Oligo-Miocene rhyolites and andesites and the Plio-Pleistocene basalts. Some surveys were also carried out on Miocene marine succession limestones and on metavolcanic rocks of the Ordovician in the Goceano subregion (Carmignani et al. 2001). In soils of the Oligo-Miocene rhyolites, the average pH is 5.8 (range: 5.4–6.2), while the pH of the andesites is 6.0 (range: 5.7–6.4). The Plio-Pleistocene basalts

have an average pH of 5.7 (range: 5.4–5.9), metavolcanic rocks of the Ordovician in the Goceano subregion 5.4 (range: 4.9–5.8), and Miocene limestones 7.6 (range 7.2–7.8).

The average annual temperature of the study area varies from 16.7°C in Olmedo (52 m) to 11.2°C in Anela (1000 m) with annual rainfall ranging from 574 to 1034 mm, respectively (Figure 1). The study area is under the influence of prevalent subhumid ombrotypes, with rainfall always exceeding 900 mm year⁻¹ above 500 m. The phytoclimatic classification, according to the proposal of Rivas-Martínez et al. (2011), recognizes two different bioclimatic regions: Mediterranean and Temperate (sub-Mediterranean variant) with the following phytoclimatic belts: upper thermomediterranean, lower and upper mesomediterranean, and lower and upper supratemperate (Farris et al. 2007b).

The majority of the vegetation surveys were gathered within Natura 2000 sites: Valley of the Temo river (ITB 000040); Internal and coastal areas between Bosa and Capo Marrargiu-Porto Tangone (ITB 000041); Plateau of Campeda (ITB 001101); and Marghine-Goceano (ITB 001102).

Data collection

In the period 2000–2004, we carried out 76 phytosociological surveys (Braun-Blanquet 1965; Biondi 2011; Pott 2011). In order to compare species richness among surveys, each survey was taken on a 2 × 2 m standard plot. Nomenclature of plant species followed Conti et al. (2005), with the exception of *Carex caryophyllea* ssp. *insularis* (according to Arrigoni

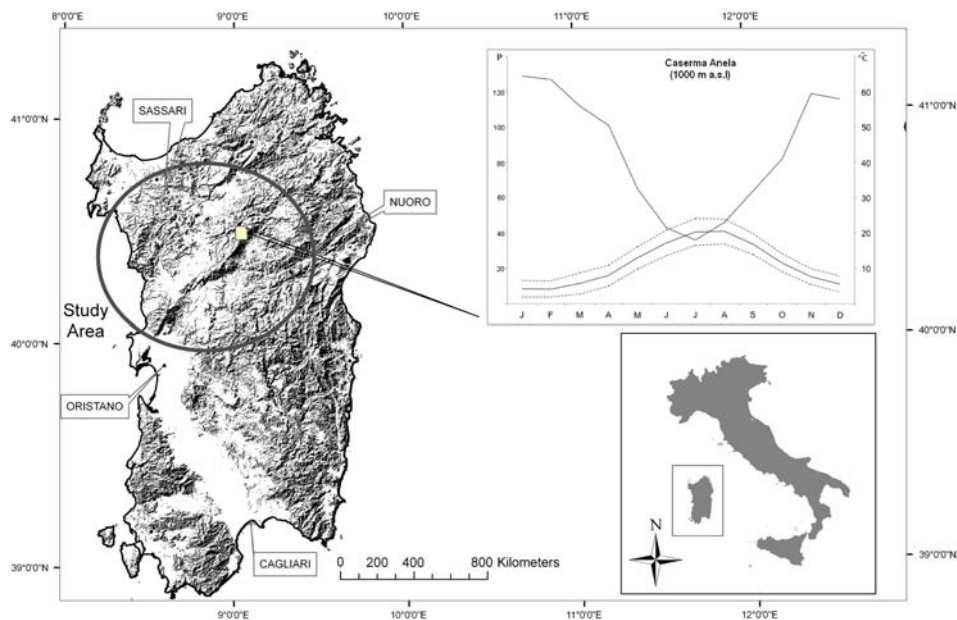


Figure 1. Study area and thermopluviometric diagram of Anela station; data refer to the period 1951–1985. Phytoclimatic diagnosis: temperate (submediterranean variant), Euoceanic upper mesotemperate lower humid. $P = 1040$ mm; $T_{med} 11.2^{\circ}\text{C}$; index of submediterraneity = 273.2 (strong submediterranean).

1984), *Cynosurus polybracteatus* (according to Pignatti 1982), *Gagea bohemica* ssp. *corsica* (according to Gamisans & Marzocchi 1996), and *Morisia monantha* (according to Corrias 1979).

Data analysis

Multivariate analyses allowed us to identify different plant communities: species composition and relative abundances were analyzed by multivariate techniques using the PRIMER software package (Plymouth Marine Laboratory, Plymouth, UK; Clarke & Warwick 1994).

Cover values were transformed according to van der Maarel (1979), and data were not standardized. The Bray–Curtis similarity matrix was used to generate a two-dimensional, unconstrained ordination plot with non-metric multidimensional scaling (NMDS) techniques. Cluster analysis was performed using the modified TWINSPLAN procedure (Roleček et al. 2009). A similarity test (ANOSIM; Clarke 1993) was performed to examine the differences among plant communities. Plant species contributing to the differences among communities were detected using the similarity percentages procedure (SIMPER; Clarke 1993). We used a similar approach to compare our communities with literature data. Syntaxonomic nomenclature was in accordance with the International Code of Phytosociological Nomenclature (Weber et al. 2000). Plant life forms (Raunkiaer 1934) were based on the collected material, whereas the chorological categories for plant species were assumed from Pignatti (1982) and grouped in wider categories (Pignatti 1994). Ellenberg indicator values according to Pignatti (2005) were used as supplementary variables to explain NMDS ordination. Furthermore, each species was

categorized at vegetation class level, following Rivas-Martinez et al. (2002). Species richness at community level was compared using ANOVA and visualized with a “box and whisker” graph.

Results

We recognized three main groups of pastures dominated by *Festuca morisiana* (F), *Poa bulbosa* (P), and *Vulpia ligustica* (V), respectively. The ordination and cluster analysis (Figure 2) showed a clear-cut separation among the three communities, and ANOSIM highlighted strong differences among the species assemblages ($R = 0.994$; $P < 0.001$). Ellenberg indicator values show that the vertical axes can be interpreted as an opposite gradient of soil moisture and temperature, whereas the horizontal axes are mainly linked to the nutrients availability. The SIMPER procedure identified the major contributors to the dissimilarities observed (Online Appendix 1) with 5–6 taxa accounting more than 30% of the dissimilarity. Dissimilarity between assemblages varied from 91.78% between V and P to 98.90% between F and P.

The comparison of biological spectra (Online Appendix 2) revealed the prevalence of perennial species in the pastures characterized by *F. morisiana*: the hemycryptophytes are always over 60% and the geophytes over 20%, while the therophytes are never over 5–10% of total frequencies. The *P. bulbosa* pastures are composed in equal parts by hemycryptophytes, geophytes, and therophytes. On the contrary, nitrophilous pastures dominated by *V. ligustica* are characterized by annual species, which account for 80% of the total frequencies.

Chorological spectra (Online Appendix 3) show the peculiarity of the *F. morisiana* community, being

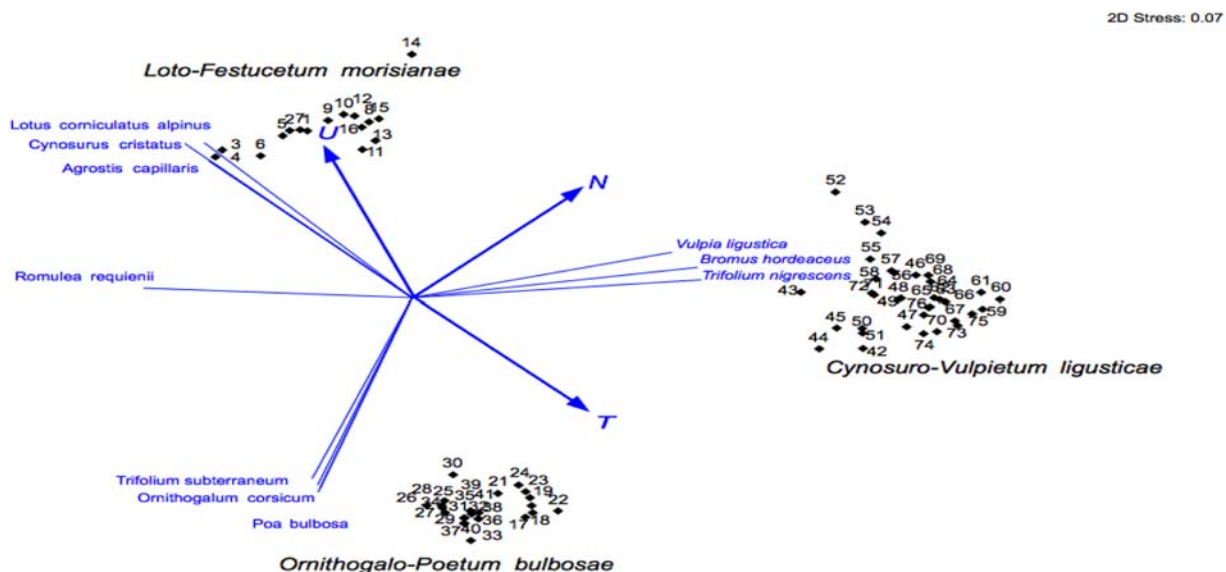


Figure 2. Two-dimensional NMDS ordination of phytosociological surveys comparing plant species assemblages. Ellenberg indicator values with axes correlation > 0.5 (Spearman rank) were plotted as supplementary variables. Only species vectors with correlation > 0.8 were plotted.

mainly constituted by endemic (20–40%) and boreal–temperate (>40%) plants that are rare or confined to wet places within the Mediterranean area. High percentages of endemic *taxa* have also been found in the *P. bulbosa* association, ranging from 10% to 38%. Unlike *F. morisiana* pastures, those characterized by *P. bulbosa* are dominated by Mediterranean *taxa*, ranging from 50% to 60%. In the *P. bulbosa* pastures, the boreal–temperate *taxa* are never over 15%. Finally, in the *V. ligustica* pastures, the endemic component is completely absent, while the Mediterranean *taxa* are increasingly dominant (70–80%).

The *Poaceae* prevail in the *F. morisiana* (>35%) and *V. ligustica* (>30%) pastures, while they are not over 10% in the *P. bulbosa* pastures where the *Asteraceae* prevail (>15%). *Cyperaceae*, *Juncaceae*, and *Ranunculaceae* show the highest frequency in the *F. morisiana* pastures and the lowest in the *V. ligustica* pastures, may be as a consequence of a decreasing soil humidity.

The prevailing vegetation classes (>50% in frequencies) were, respectively, *Molinio-Arrhenatheretea* (*F. morisiana* pastures), *Poetea bulbosae* (*P. bulbosa* pastures), and *Stellarietea mediae* (*V. ligustica* pastures). In relation to the different soil humidity, in the *F. morisiana* pastures the species of the *Isoeto-Nanojuncetea* are well represented (>10%), whereas in the *V. ligustica* and *P. bulbosa* pastures a big proportion of species of the *Helianthemetea guttati* (nearly 20%) has been detected.

Comparison with literature data (not shown here) revealed that the communities highlighted by the multivariate analysis could be referred to three new plant associations, as described below.

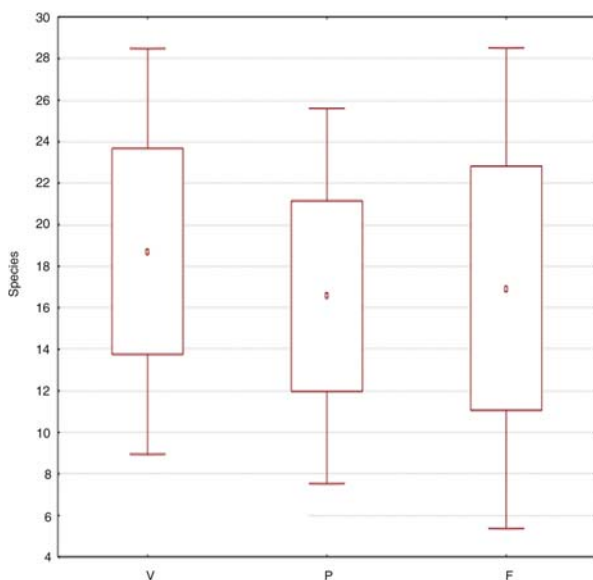


Figure 3. Box and whisker plots of species richness between the surveyed communities: V = *V. ligustica* comm.; P = *P. bulbosa* comm.; F = *F. morisiana* comm.

Finally, the species richness does not show significant differences ($p > 0.05$) among the communities (Figure 3): ranging from 3.2 species 1 m^{-2} to 6.4 species 1 m^{-2} even if the evenness is noticeably lower in the *V. ligustica* community.

Vegetation description

Loto alpini-Festucetum morisiana ass. nova hoc loco (typus rel. no. 1, Table I).

Physiognomy: Dense, low height (10–20 cm) pasture, heavily grazed by sheep and cattle.

Species composition: Perennial pasture characterized by the contemporaneous presence of perennial European temperate species (*Agrostis capillaris*, *Anthoxanthum odoratum*, *Cynosurus cristatus*, *Danthonia decumbens*, *Holcus lanatus*, *Lotus corniculatus* ssp. *alpinus*) and several Sardinian and Sardinian–Corsican mountain endemics (e.g. *C. caryophyllea* ssp. *insularis*, *Cerastium palustre*, *F. morisiana*, *Oenanthe lisae*, and *Ranunculus cordiger* ssp. *cordiger*). Mediterranean species are nearly absent in the *A. odoratum* variant, whereas in the other surveys they show a frequency < 15%.

Ecology: This perennial grassland grows on wet soils that are snowy on average for 30 days per year and flooded for 4–6 months; summer drought is reduced to less than 2 months. They are found at an average altitude of 1000 m in the upper mesotemperate–lower supratemperate, humid phytoclimatic belts. This association was found on Oligo-Miocenic trachytes in the Marghine area, whereas the *A. odoratum* variant is exclusive of the metamorphic schists in the Goceano area.

Distribution: Exclusive of Sardinia in the Marghine-Goceano mountain range: this is the first time that some *taxa* as *F. morisiana* and *R. cordiger* ssp. *cordiger* are reported outside the Gennargentu massif, to which they were considered exclusive (Arrigoni 1982, 1983b).

Syndynamics: This association is included in the *Glechomo sardoae-Quercetum congestae* vegetation series, whereas the *A. odoratum* variant is part of the *Saniculo europaeae-Quercetum ilicis* series (Bacchetta et al. 2009).

Syntaxonomy: A community dominated by *F. morisiana* was already described as *Festucetum morisiana* (Nimis 1980; Arrigoni 1986), an association found on the steep slopes of the Gennargentu massif, at an altitude from 1550 to 1800 m. Phytoclimatic belt, litho-morphological conditions and species assemblages clearly separate the *Festucetum morisiana* from the herein described community. In particular, slight or absent slope in the latter causes a remarkable water stagnation that allows the presence of several plants linked to wet soils, such as *C. palustre*, *D. decumbens*, *H. lanatus*, *Juncus*

Table I – continued

		Survey number																		
		Altitude (m a.s.l.)																		
		1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	16		
		950	950	950	950	950	950	950	976	976	976	965	965	965	1038	890	1050	1050		
		R	R	R	R	R	R	R	M	M	M	M	M	M	M	M	M	M		
Substratum: R = Oligo-Miocene																				
Rhyolites; M = Metavolcanites;																				
Cover total (%)		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100		
Aspect		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Slope (%)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Number of species		20	6	13	13	14	10	15	21	27	23	15	18	28	13	16	19	19		
																		Pres.		
Europ.-Cauc.	H caesp	+	.	.	.	.	.	1	+	.	.	.	.	.	.	+	.	5
Eurimedit.	Ch suffr	+	.	.	.	.	.	1	+	.	.	.	.	.	.	1	.	4
Stenomedit.	G rhiz	.	.	.	.	.	.	.	1	+	.	.	.	.	+	.	.	4
Eurosib.	H caesp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	3
Endem.																				
Sa-Co-Its	G rhiz	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	+	3
Paleotemp.	T scap	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	3
Eurimedit.	T scap	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Paleotemp.	H caesp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Stenomedit.	T scap	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	2
Eurasiat.	H caesp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2
Endem.																				
Sa-Co-AT-BI	H scap	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
SW-Medit	T scap	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2
Eurimedit.	T rept	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.	2
Eurimedit.	H scap	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	1	2
Eurimedit.	T scap	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	2

articulatus, *Juncus conglomeratus*, *L. corniculatus* ssp. *alpinus*, *O. lisa*, *Orchis laxiflora*, and *R. cordiger* ssp. *cordiger*. On the other side, chamaephytes are absent from our surveys, but are abundant in the *Festucetum morisianae* association. In fact, *Festucetum morisianae* cannot be clearly ascribed to *Molinio-Arrhenatheretea* class and it was included until now in *Carici-Genistetetea lobelii* (= *Carlinetea macrocephalae*). These ecological and floristic differences allow us to consider the community studied here as a new association and to describe it as *Loto alpini-Festucetum morisianae*.

Ornithogalo corsici-Poetum bulbosae ass. nova hoc loco (typus rel. no. 56, Table II).

Physiognomy: Low height (5–10 cm), dry, sheep pasture.

Species composition: This community is composed almost equally by hemicryptophytes such as *P. bulbosa*, *Ranunculus paludosus*, and *Leontodon tuberosus*; therophytes such as *Trifolium subterraneum*, *Parentucellia latifolia*, and *Cerastium glomeratum*; and geophytes such as *Crocus minimus*, *Ornithogalum corsicum*, and *Romulea requienii*. The chorological analysis shows the equal contribution of endemic, stenomediterranean, and eurimediterranean taxa; European plants are not over 10% in frequency; the wide distribution plants are nearly absent.

Ecology: it is a man-maintained pasture, the characteristic species of which are selected by sheep grazing. It is present on different substrata, but it covers large areas on the volcanic plateaus ranging from 340 to 1050 m, from the lower mesomediterranean to the upper supratemperate (in the submediterranean variant) phytoclimatic belts. The typical subassociation *romuleetosum ligusticae* subass. nova hoc loco (typus rel. no. 56, Table II) is found in the Mediterranean phytoclimatic belts; the subassociation *gagetosum corsicae* subass. nova hoc loco (typus rel. no. 61, Table II), differentiated by *G. bohemica* ssp. *corsica* and *Veronica verna* ssp. *brevistyla*, is found in the submediterranean phytoclimatic belt on dry soils; the subass. *morisietosum monanthes* subass. nova hoc loco (typus rel. no. 71, Table II), differentiated by *M. monantha* and *Allium chamaemoly*, grows in the submediterranean phytoclimatic belt on wet soils.

Distribution: Exclusive of central-northern Sardinia.

Syndynamics: They are secondary communities originated as a consequence of grazing activity and linked to several vegetation series, which are dominated by: cork-oak (*Violo dehnhardtii-Quercetum suberis*), holm-oak (*Prasio majoris-Quercetum ilicis*, *Galio scabri-Quercetum ilicis*, and *Saniculo europaeae-Quercetum ilicis*), and by deciduous oaks (*Ornithogalo pyrenaici-Quercetum ichnusae* and *Glechomo sardoae-Quercetum congestae*).

Syntaxonomy: A community dominated by *P. bulbosa* and *T. subterraneum* was described for Sardinian sheep pastures as *Poo bulbosae-Trifolietum subterranei* subass. *trifolietosum nigrescentis* (Ladero et al., 1992), later upgraded at the association level as *Trifolio nigrescentis-Poetum bulbosae* (Galán de Mera et al., 2000). However, our analysis highlighted a clear-cut separation between our surveys and those gathered by Ladero et al. (1992) with a dissimilarity > 70% (multivariate analysis, SIMPER test, Online Appendix 4). This dissimilarity is due to more nitrophilous species, which are absent in our association, whereas endemic taxa are absent from that described by Ladero et al. (1992). These findings suggest to describe a new association named *Ornithogalo corsici-Poetum bulbosae* ass. nova, with three subassociations, and led us to consider the *Trifolio nigrescentis-Poetum bulbosae* as a more nitrophilous community, transitional between the *Poetea bulbosae* and the *Stellarietea mediae* classes.

Cynosuro polybracteati-Vulpietum ligusticae ass. nova hoc loco (typus rel. no. 48, Table III).

Physiognomy: Average size ploughed pasture (20–30 cm), mainly constituted by therophytes.

Specific composition: *V. ligustica*, *Bromus hordeaceus*, *Trifolium nigrescens*, and *C. polybracteatus* prevail. This association is characterized by Mediterranean species: stenomediterranean, eurimediterranean, and Atlantic-Mediterranean taxa constitute roughly 80%. Endemic taxa are absent, whereas wide distribution species are over 10% in frequency.

Ecology: Herbaceous annual community, growing on eutrophic soils ploughed at least once a year. Ploughing allows the burying of sheep dung thus increasing the organic matter in the soil. This community can be found mainly on Oligo-Miocenic trachytes. Four variants having different ecology can be recognized: the typical variant grows from 550 to 1000 m; the *Hordeum marinum* ssp. *gussoneanum* variant is the most thermophilous growing from 250 to 600 m.; the *Silene laeta* variant grows only on wet soils, sometimes in the presence of short water stagnation; the *Aira cupaniana* variant is a pioneer community on stony or eroded soils.

Distribution: North-Western Sardinia.

Syndynamics: This association is mainly related to the *Violo dehnhardtii-Quercetum suberis* vegetation series and partially to the *Ornithogalo pyrenaici-Quercetum ichnusae* series (Bacchetta et al. 2009).

Syntaxonomy: Land use and general ecological features can be related to the coenoses of class *Stellarietea* and *Echio-Galactition* alliance, but no associations having floristic composition similar to our surveys were found in literature data. We therefore propose the new association *Cynosuro polybracteati-Vulpietum ligusticae* ass. nova characterized by four variants.

Discussion and conclusions

The floristic, ecological, and chorological analyses revealed that the investigated pastures can be ascribed to three different communities: (i) perennial mountainous meso-supratemperate cattle and sheep pastures (*Loto alpini-Festucetum morisianae*); (ii) mixed (annual and perennial) lower thermomediterranean to lower supratemperate sheep pastures (*Ornithogalo corsici-Poetum bulbosae*); and (iii) annual ploughed subnitrophilous Mediterranean and Temperate pastures (*Cynosuro polybracteati-Vulpium ligusticae*). *Loto-Festucetum* replaces *Ornithogalo-Poetum* along an altitudinal increasing gradient, whereas *Cynosuro-Vulpium* is determined as the main consequence of soil ploughing.

Lacking several central European species and hosting numerous endemics, Temperate mountainous pastures in the central islands were previously classified, at higher level, in different endemic syntaxa (e.g. Brullo & Grillo 1978; Pignatti Wikus et al. 1980; Arrigoni 1986; Gamisans 1991). We do not recognize that it is appropriate to classify hemicryptophytic pastures into a chamaephyte dominated class (*Carici-Genistetea*) or to join them with the high mountainous pastures (e.g. Pignatti Wikus et al. 1980; Gamisans 1991), but, despite a distinct floristic impoverishment compared to the continental *Molinio-Arrhenatheretea* communities, we sustain that Sardinian Temperate mountainous pastures (*Loto-Festucetum*) and the correspondent Corsican communities should be referred to the *Molinio-Arrhenatheretea* class, because all of them share a similar floristic composition with the presence and abundance of *A. odoratum*, *C. cristatus*, *L. corniculatus*, and *Trifolium repens*. As they host numerous endemic taxa, we consider their inclusion as appropriate in an endemic suballiance – *Danthonio decumbentis-Caricinion insularis* suball. *nova hoc loco* (typus *Loto-Festucetum morisianae* ass. *nova hoc loco*) – differentiating in the Sardinian–Corsican biogeographic province the pasture communities referred to the Central European alliance *Cynosurion cristati*. The new suballiance is differentiated by *C. caryophyllea* ssp. *insularis*, *Bellium bellidioides*, *D. decumbens*, *Mentha insularis*, and *Luzula spicata* ssp. *italica* (see Online Appendix 5). This suballiance is the appropriate upper syntaxon which comprises also the Corsican communities described as *Carici-Potentilletum reptantis* and *Ophioglossum vulgati-Nardetum strictae* (Gamisans 1976). A similar syntaxonomical framework, but at the alliance level, was used for the Sicilian communities that were classified in an endemic alliance (*Plantaginion cupanii*) and an endemic order (*Cirsietalia vallis demonis*) by Brullo and Grillo (1978). The lacking of species belonging to the *Arrhenatheretalia* order, the scarcity of

ingressive ones from the *Festuco-Brometea* class, and the presence of an abundant endemic component are common features of both Sicilian and Sardinian–Corsican pastures with respect to the continental communities of the *Cynosurion cristati* alliance (for a detailed comparison between European and Italian *Cynosurion cristati* communities, see Blasi et al. (2009, 2012a)). In this paper, as the knowledge about the pastures of *Danthonio decumbentis-Caricinion insularis* in Sardinia and Corsica is still scarce, we prefer to not define a new order within the *Molinio-Arrhenatheretea* class replacing the Sicilian and the Continental ones, but to place provisionally this newly described suballiance into the *Cynosurion cristati* alliance, highlighting the need for more data from unsurveyed areas of Sardinia and Corsica.

With regard to the Mediterranean ovine pastures, they are placed at the eastern range of the *Poetea bulbosae* class and *Periballio-Trifolium subterranei* alliance (Galán de Mera et al., 2000), testified by a quite different floristic composition. In fact, between the characteristic species of *Periballio-Trifolium subterranei* (Rivas-Martínez et al., 2002) only *Trifolium glomeratum* and *T. subterraneum* are present in Sardinia, whereas *Astragalus cymbaearpos*, *Trifolium gemellum*, and *Ranunculus pseudomillefoliatus* are found exclusively in the Iberian Peninsula. In addition, the Sardinian communities present endemic flora that justify the institution of a new suballiance named *Ornithogalo corsici-Trifolienion subterranei* (typus *Ornithogalo corsici-Poetum bulbosae*). Characteristic species *C. minimus*, *G. bohemica* ssp. *corsica*, *M. monantha*, *O. corsicum*, *R. requienii*, and *V. verna* ssp. *brevistyla* can be considered. As a consequence, the typicum suballiance *Periballio-Trifolienion subterranei* (holotypus *Poo bulbosae-Trifolietum subterranei*) is *hoc loco* instituted and differentiated by *A. cymbaearpos*, *T. gemellum*, and *R. pseudomillefoliatus*. A synoptic table of *Ornithogalo-Poetum bulbosae* and *Trifolium nigrescentis-Poetum bulbosae* is shown in the Online Appendix 6.

Lastly, the annual semi-nitrophilous pastures of *Cynosuro-Vulpium* could be referred to as the *Stellarietea mediae* class, order *Thero-Brometalia*, and alliance *Echio plantaginei-Galactition tomentosae*, an alliance that includes the western thermo-mesomediterranean humid–subhumid communities growing on soils rich in organic matter. As a comparison, we compiled a synoptic table with the analogous communities from Central Italy (Online Appendix 7) reported in Blasi et al. (2012b).

The higher incidence of endemic taxa in each one of the subassociations referred to *Molinio-Arrhenatheretea* and *Poetea bulbosae* confirms the conservation value of these semi-natural habitats linked to the traditional livestock grazing and peculiarly placed at the Southern phytogeographic border of the *Molinio-*

Arrhenatheretea class and at the eastern of the *Poetea bulbosae*. Even if no significant differences in total species richness were found, the ploughed and unploughed communities are clearly differentiated in terms of structure, chorology, composition, and conservation value showing a conspicuous decrease in the endemic component linked to changes in management practices (e.g. soil tillage and fertilization).

Cynosurion cristati communities are not a habitat of European concern *sensu* 43/92/EEC Directive as they are a broadly ranged and hosting prevalently species with a wide distribution. On the other hand, in the Sardinian–Corsican Province they are priority for conservation purposes, due to the high number of rare endemic plants and the relic significance of several boreal–temperate species confined to humid places in Mediterranean mountain ranges: among the others, the high frequency in the *Loto alpini-Festucetum morisiana* of *C. palustre* is noteworthy, because this is considered one of the most threatened Sardinian vascular plants (Bacchetta et al. 2012). On the contrary, the conservation value of the Mediterranean ovine pastures has been recognized at EU level within the priority habitat 6220, including the communities belonging to *Thero-Brachypodietea s.l.*, *Lygeo-Stipetea*, and *Poetea bulbosae* (European Commission 2007). Despite this, a broad structural, compositional and functional heterogeneity, as for different conservation values, can be found in the coenoses belonging to the habitat 6220, therefore preventing from outlining common management strategies (Farris et al. 2007a). Coherently with the floristic compositions, the investigated *Stellarietea mediae* pastures have a low conservation value and cannot be referred to as an EU Habitat.

This study not only confirms the crucial role of man-induced grazing in shaping the population structure and recruitment (Farris & Filigheddu 2008; Farris et al. 2009, 2012) and the demography (Pisanu et al. 2012) of Mediterranean plants, but also underlines the pivotal role of the traditional shepherding in positively affecting the species richness and diversity within and among pastoral communities at the landscape level (Farris et al. 2007a, 2010).

We argue that the presented approach is cost-effective and could be applied to different semi-natural habitats in the Mediterranean and European context to identify the coenoses conservation value. The phyto(socio)-ecological and phytogeographical characterization of communities can help to give examples of target habitats in terms of composition and structure in restoration ecology actions and monitoring and to address conservation efforts. Vegetation classification is a useful tool for basic and applied research as well for environmental

management (De Caceres & Wiser 2012): analyzing and characterizing plant communities are crucial before taking actions in habitat conservation in order not to sow the tares with the wheat!

Syntaxonomic scheme (other syntaxonomic units quoted in the text are reported in the Online Appendix 8)

Stellarietea mediae Tüxen, Lohmeyer & Preising ex von Rochow, 1951

Thero-Brometalia (Rivas Goday & Rivas-Martínez ex Esteve, 1973) O. Bolòs, 1975

Echio plantaginei-Galactition tomentosae O. Bolòs & Molinier, 1969

Cynosuro polybracteati-Vulpium ligusticae ass. nova hoc loco

Poetea bulbosae Rivas Goday & Rivas-Martínez in Rivas-Martínez, 1978

Poetalia bulbosae Rivas Goday & Rivas-Martínez in Rivas Goday & Ladero, 1970

Periballio-Trifolion subterranei Rivas Goday 1964 nom. inv. propos. Rivas-Martínez et al., 2002

Ornithogalo corsici-Trifolienion subterranei suball. nova hoc loco

Ornithogalo corsici-Poetum bulbosae ass. nova hoc loco

romuleetosum ligusticae subass. nova hoc loco

gageetosum corsicae subass. nova hoc loco

morisietosum monantheae subass. nova hoc loco

Molinio-Arrhenatheretea Tüxen, 1937

? *Arrhenatheretalia* Tüxen, 1931

Cynosurion cristati Tx., 1947

Danthonio decumbentis-Caricion insularis suball. nova hoc loco

Carici-Potentilletum reptantis Gamisans, 1976

Loto alpini-Festucetum morisiana ass. nova hoc loco

Ophioglosso vulgati-Nardetum strictae Gamisans, 1976

Acknowledgements

The authors would like to thank Umberto Pirisi, Giulia Mameli, and Alessio Ortu for their help while gathering data in the field, whereas Marta Leo made a linguistic revision of the manuscript.

Gratitude is also due to the staff of the forestry stations of Foresta Anela (Anela-SS) and Fiorentini (Bultei-SS) of the Ente Foreste della Sardegna (Forestry Board of Sardinia) for providing a logistic base and for the genuine hospitality offered throughout the research project. This work would not have been possible without the authorisation of the Ente Foreste della Sardegna to accede to the areas it manages. The Fondazione Banco di Sardegna financed a research grant for the topic “The shrub communities in the terrestrial ecosystems of NW Sardinia: potential use in programmes for reforestation and conservation of biodiversity” held by E. Farris, while the Consorzio per la Promozione degli Studi Universitari della Sardegna Centrale financed the “Fellowship for young graduates in the environmental sciences” held by Z. Secchi.

References

- Arrigoni PV. 1982. Le piante endemiche della Sardegna: 101-*Festuca morisiana* Parlatore. Boll Soc Sarda Sci Nat 21: 349–353.
- Arrigoni PV. 1983a. Aspetti corologici della flora sarda. Lavori Soc It Biogeogr ns 8: 83–109.
- Arrigoni PV. 1983b. Le piante endemiche della Sardegna: 121-*Ranunculus cordiger* Viviani. Boll Soc Sarda Sci Nat 22: 277–283.
- Arrigoni PV. 1984. Le piante endemiche della Sardegna: 140-*Carex caryophyllea* Latourr. ssp. *insularis* (Christ ex Barbey) Arrigoni, stat. nov. Boll Soc Sarda Sci Nat 23: 220–224.
- Arrigoni PV. 1986. Contributo alla conoscenza della vegetazione del Monte Gennargentu, in Sardegna. Boll Soc Sarda Sci Nat 25: 63–96.
- Bacchetta G, Bagella S, Biondi E, Farris E, Filigheddu R, Mossa L. 2009. Vegetazione forestale e serie di vegetazione della Sardegna (con rappresentazione cartografica alla scala 1:350.000). Fitosociologia 46(1, Suppl. 1): 3–82.
- Bacchetta G, Farris E, Pontecorvo C. 2012. A new method to set conservation priorities in biodiversity hotspots. Plant Biosyst 146(3): 638–648.
- Biondi E. 2011. Phytosociology today: Methodological and conceptual evolution. Plant Biosyst 145(Suppl. 1): 19–20.
- Blasi C, Burrascano S, Del Vico E, Di Pietro R, Iocchi M, Rosati L. 2009. *Cynosurion cristati* grasslands in the central Apennines (Tyrrhenian sector): A phytosociological survey in the Lepini and Prenestini mountains. Plant Biosyst 143(3): S69–S77.
- Blasi C, Tilia A, Rosati L, Del Vico E, Copiz R, Ciaschetti G, et al. 2012a. Geographical and ecological differentiation in Italian mesophilous pastures referred to the alliance *Cynosurion cristati* Tx. 1947. Phytocoenologia 41(4): 217–229.
- Blasi C, Facioni L, Burrascano S, Del Vico E, Tilia A, Rosati L. 2012b. Submediterranean dry grasslands along the Tyrrhenian area of central Italy: synecology, syndynamics and syntaxonomy. Plant Biosyst 146: 266–290.
- Braun-Blanquet J. 1965. Plant sociology. The study of plant community. New York and London: Hafner Publishing Company.
- Bruno S, Grillo M. 1978. Ricerche fitosociologiche sui pascoli dei Monti Nebrodi (Sicilia settentrionale). Not Fitosoc 13: 23–61.
- Carmignani L, Oggiano G, Barca S, Conti P, Salvadori I, Eltrudis A, et al. 2001. Memorie descrittive della Carta Geologica d'Italia, 8, Note illustrative della Carta Geologica della Sardegna a scala 1:200.000. Roma
- Clarke KR. 1993. Non-parametric multivariate analyses of changes in community structure. Aust J Ecol 18: 117–143.
- Clarke KR, Warwick RM. 1994. Change in marine communities: An approach to statistical analysis and interpretation. Swindon: Natural Environment Research Council.
- Clergue B, Amiaud B, Pervanchon F, Lasserre-Joulin F, Plantureux S. 2005. Biodiversity: function and assessment in agricultural areas. A review. Agron Sustain Dev 25: 1–15.
- Conti F, Abbate G, Alessandrini A, Blasi C, editors. 2005. An annotated checklist of the Italian vascular flora. Roma: Palombi Editori.
- Corrias B. 1979. Le piante endemiche della Sardegna: 55-*Morisia monantha* (Viv.) Ascherson ex Barbey. Boll Soc Sarda Sci Nat 18: 303–309.
- De Caceres M, Wiser S. 2012. Towards consistency in vegetation classification. J Veg Sci 23(2): 387–393.
- Dullinger S, Dirnbock T, Greimler J, Grabherr G. 2003. A resampling approach for evaluating effects of pasture abandonment on subalpine plant species diversity. J Veg Sci 14: 243–252.
- Ejrnæs R, Bruun HH, Aude E, Buchwald E. 2004. Developing a classifier for the habitats directive grassland types in Denmark using species lists for prediction. Appl Veg Sci 7: 71–80.
- European Commission. 2007. Interpretation manual of European Union Habitats. Brussels, European Commission: DG Environment.
- Farris E, Filigheddu R. 2008. Effects of browsing in relation to vegetation cover on common yew (*Taxus baccata* L.) recruitment in Mediterranean environments. Plant Ecol 199: 309–318.
- Farris E, Filigheddu R, Deiana P, Farris GA, Garau G. 2010. Short-term effects on sheep pastureland due to grazing abandonment in a Western Mediterranean island ecosystem: A multidisciplinary approach. J Nat Conserv 18: 258–267.
- Farris E, Pisanu S, Ceccherelli G, Filigheddu R. 2009. Effects of the management regime on the performance of the endangered Mediterranean *Centaurea horrida* Badarò (Asteraceae). J Nat Conserv 17: 15–24.
- Farris E, Pisanu S, Ceccherelli G, Filigheddu R. 2012. Variability at local scales and between habitats in population structure and reproductive traits of the Mediterranean plant *Centaurea horrida*: Implications for management. J Coast Res 28: 193–198.
- Farris E, Secchi Z, Filigheddu R. 2007a. Caratterizzazione fitosociologica dell'habitat prioritario 6220*–“Percorsi substeppici di graminacee e piante annue dei *Thero-Brachypodietea*”: caso di studio della Sardegna settentrionale. Fitosociologia 44(2, Suppl. 1): 271–278.
- Farris E, Secchi Z, Filigheddu R. 2007b. Phytosociological study of the shrub and pre-forest communities of the effusive substrata of NW Sardinia. Fitosociologia 44(2): 55–81.
- Galán de Mera A, Morales RA, Vincente Orellana JA. 2000. Pasture communities linked to ovine stock. A synthesis of the *Poetea bulbosae* class in the western Mediterranean Region. Phytocoenologia 30(2): 223–267.
- Gamisans J. 1976. La végétation des montagnes corses. Phytocoenologia 3(4): 425–498.
- Gamisans J. 1991. La végétation de la Corse. In: Jeanmonod D, Burdet HM, editors. Compléments au podrome de la flore corse. Geneva: Conservatoire et Jardin botaniques de la Ville de Genève. pp. 1–391.
- Gamisans J, Marzocchi JF. 1996. La flore endémique de la Corse. Aix-en-Provence: Edisud.
- Janišová M, Bartha S, Kiehl K, Dengler J. 2011. Advances in the conservation of dry grasslands: Introduction to contributions

- from the seventh European Dry Grassland Meeting. *Plant Biosyst* 145: 507–513.
- Kleijn D, Sutherland WJ. 2003. How effective are European agri-environment schemes in conserving and promoting biodiversity? *J Appl Ecol* 40: 947–969.
- Koocheki A, Gliessman SR. 2005. Pastoral nomadism, a sustainable system for grazing land management in arid areas. *J Sust Agr* 25: 113–131.
- Ladero M, Biondi E, Mossa L, Amor A. 1992. Los pastizales mediterráneos presididos por *Trifolium subterraneum* L. en la isla de Cerdeña (Italia). *Doc Phytosoc* 14(8): 45–54.
- Muller S. 2002. Appropriate agricultural management practices required to ensure conservation and biodiversity of environmentally sensitive grassland sites designated under Natura 2000. *Agr Ecosyst Environ* 89: 261–266.
- Myklestad Å, Sætersdal M. 2004. The importance of traditional meadow management techniques for conservation of vascular plant species richness in Norway. *Biol Conserv* 118: 133–139.
- Nentwig W. 2003. Management of biodiversity in agroecosystems. *Basic Appl Ecol* 4: 105–106.
- Nimis P. 1980. Vegetazione altimontana ad arbusti spinosi del sistema sardo-corso. Associazioni vegetali. In: Pignatti Wikus E, Pignatti S, Nimis P, Avanzini A, editors. *La vegetazione ad arbusti spinosi emisferici: contributo alla interpretazione delle fasce di vegetazione delle alte montagne dell'Italia mediterranea*. Collana Prog. Finalizzato AQ/1/79: Promozione della Qualità dell'ambiente Roma: C.N.R.. pp. 45–52.
- Ostermann OP. 1998. The need for management of nature conservation sites designated under Natura 2000. *J Appl Ecol* 35: 968–973.
- Pignatti S. 1982. *Flora d'Italia*. Bologna: Edagricole. vol. 1–3.
- Pignatti S. 1994. *Ecologia del paesaggio*. Torino: UTET.
- Pignatti S. 2005. Valori di bioindicazione delle piante vascolari della flora d'Italia. *Braun-Blanquetia*: 3–97.
- Pignatti Wikus E, Pignatti S, Nimis P, Avanzini A, editors. 1980. *La vegetazione ad arbusti spinosi emisferici: contributo alla interpretazione delle fasce di vegetazione delle alte montagne dell'Italia mediterranea*. Collana Prog. Finalizzato AQ/1/79: Promozione della Qualità dell'ambiente Roma: C.N.R..
- Pisanu S, Farris E, Filigheddu R, García MB. 2012. Demographic effects of large, introduced herbivores on a long-lived endemic plant. *Plant Ecol* 213: 1543–1553.
- Primdahl J, Peco B, Schramek J, Andersen E, Onate JJ. 2003. Environmental effects of agri-environmental schemes in Western Europe. *J Environ Manage* 67: 129–138.
- Pott R. 2011. *Phytosociology: A modern geobotanical method*. *Plant Biosyst* 145(Suppl.): 9–18.
- Raunkiaer C. 1934. *The life forms of plants and statistical plant geography*. Oxford: Oxford University Press, 632 pp.
- Rivas-Martínez S, Díaz TE, Fernández-González F, Izco J, Loidi J, Lousã M, et al. 2002. Vascular plant communities of Spain and Portugal. *Itiner Geobot* 15(2): 433–922.
- Rivas-Martínez S, Rivas-Saenz S, Merino AP. 2011. Worldwide bioclimatic classification system. *Global Geobotany* 1: 1–638.
- Roleček J, Tichý L, Zelený D, Chytrý M. 2009. Modified TWINSPAN classification in which the hierarchy respects cluster heterogeneity. *J Veg Sci* 20: 596–602.
- Sanderson MA, Skinner RH, Barker DJ, Edwards GR, Tracy BF, Wedin DA. 2004. Plant species diversity and management of temperate forage and grazing land ecosystems. *Crop Sci* 44: 1132–1144.
- Stewart GB, Pullin AS. 2008. The relative importance of grazing stock type and grazing intensity for conservation of mesotrophic 'old meadow' pasture. *J Nat Conserv* 16: 175–185.
- Stoate C, Boatman ND, Borralho RJ, Carvalho CR, de Snoo GR, Eden P. 2001. Ecological impacts of arable intensification in Europe. *J Environ Manage* 63: 337–365.
- van der Maarel E. 1979. Transformation of cover-abundance values in phytosociology and its effect on community similarity. *Vegetatio* 39: 97–114.
- Vassilev K, Pedashenko H, Nikolov SC, Apostolova I, Dengler J. 2011. Effect of land abandonment on the vegetation of upland semi-natural grasslands in the Western Balkan Mts., Bulgaria. *Plant Biosyst* 145: 654–665.
- Weber HE, Moravec J, Theurillat J-P. 2000. *International code of phytosociological nomenclature*. *J Veg Sci* 11: 739–768, 3rd ed..

Appendix A: Date and locality of the surveys

Table I. 1 – 23 May 2003-Mandra Pudatta (Bolotana-NU); 2/3/4/5/6/7 – 03 August 2003-Mandra Pudatta (Bolotana-NU); 8/9/10 – 05 June 2003-Orrosile (Bultei-SS); 11/12 – 05 June 2003-Fontana Arile, Foresta Anela (Anela-SS); 13 – 11 June 2001-Fontana Arile, Foresta Anela (Anela-SS); 14 – 05 June 2003-S'Ena de Lottori (Bultei-SS); 15 – 05 June 2001-Solorche (Pattada-SS); 16 – 04 July 2003-dopo Nostra Signora de S'Altura (Bultei-SS).

Table II. 52/53 – 28 April 2003-Coa 'e Mandras (Bolotana-NU); 54/55 – 28 Apr 2003-Santa Maria de Sauc (Bortigali-NU); 56/57 – 09 Apr 2003-Strada per Frida (Illorai-SS); 58/59 – 09 Apr 2003-Incrocio Ittireddu-Mores-Foresta Burgos (Bono-SS); 60/61/62/63/64/65/66/67/68 – 18 Mar 2003-Sotto Punta Masiennera, Foresta Anela (Anela-SS); 69 – 28 Apr 2003-Badde Salighes (Bolotana-NU); 70 – 18 Mar 2003-Ortakis (Bolotana-NU); 71/72/73/74/75 – 27 Apr 2003-Mandra Pudatta (Bolotana-NU); 76 – 02 Mar 2004-Pottu Codinu (Villanova Monteleone-SS).

Table III: 17/18/19 – 15 May 2002-Ponte Caitta (Villanova Monteleone-SS); 20 – 15 May 2002-Nuraghe Appiu (Villanova Monteleone-SS); 21/22/23 – 20 May 2002-Monte Fulcadu (Villanova Monteleone-SS); 24 – 17 May 2002-Sa Falada de sos Turcos (Villanova Monteleone-SS); 25/27/35 – 15 May 2002-Su Bullone (Alghero-SS); 26 – 20 May 2002-Sa Pittada (Bosa-OR); 28/32 – 16 May 2003-Planu Chelvori (Bonorva-SS); 29 – 16 May 2003-Punta Pellegrina (Bono-SS); 30/31 – 16 May 2003-Scaladeroccu (Mores-SS); 33 – 5 May 2002-Su Bullone (Villanova Monteleone-SS); 34 – 15 May 2002-Su Bullone (Alghero-SS); 36 – 17 May 2002-Su Bullone (Villanova Monteleone-SS); 37 – 15 May 2002-Confinde comunale tra Montresta (OR) e Villanova Monteleone (SS); 38 – 02 May 2003-Strada Foresta Burgos-Ittireddu (Bono-SS); 39 – 02 May 2003-Riu Badde Pedrosu (Bono-SS); 40 – 02 May 2003-Abbialzu (Bono-SS); 41 – 29 April 2003-Rio Sos Chircos (Illorai-SS); 42 – 28 April 2003-Abba Lughia (Bolotana-NU); 43 – 28 April 2003-Bivio per Badde Salighes (Bolotana-NU); 44/45/46 – 28 April 2003-Badde Salighes (Bolotana-NU); 47 – 19 May 2003-Badde Idda (Illorai-SS); 48/49 – 02 May 2003-Bivio Ittireddu-Nughedu-Bono (Bono-SS); 50/51 – 16 May 2003-Badde Salighes (Bolotana-NU).

Appendix B: Sporadic species

Table I. Rel. 1 *O. corsicum* Jord. et Fourr. (1); Rel. 10 *Centaureum maritimum* (L.) Fritsch (+); Rel. 13 *Geranium lucidum* L. (1), *Poa bulbosa* L. (+), *Rubus ulmifolius* Schott (+); Rel. 14 *Bellis annua* L. (2), *Allium roseum* L. (+); Rel. 9 *Rumex acetosella* L. (+), *Trifolium strictum* L. (+), *Dactylorhiza insularis* (Sommier) Landwehr (+), *Colchicum*

alpinum Lam. et DC. subsp. *parvulum* (Ten.) Arcang. (+);
Rel. 10 *Saxifraga bulbifera* L. (+).

Table II. Rel. 52 *Vulpia sicula* (Presl) Link (1); Rel. 55
Plantago lanceolata L. (+); Rel. 76 *Galactites elegans* (All.)
Soldano (+).

Table III. Rel. 42 *Orchis papilionacea* L. (r); Rel. 44 *O.*
corsicum Jord. et Fourr. (+); Rel. 46 *Ophrys tenthredinifera*

Willd. (+); Rel. 50 *L. tuberosus* L. (r); Rel. 47 *Stachys*
arvensis (L.) L. (r); Rel. 48 *Lathyrus cicera* L. (+); Rel. 17
Oenanthe crocata L. (r), *Vicia villosa* Roth (+), *Vulpia sicula*
(Presl) Link (+); Rel. 18 *Linaria pelisseriana* (L.) Miller
(+), *Daucus carota* L. (r); Rel. 40 *Gaudinia fragilis* (L.)
Beauv. (+), *Erophila verna* (L.) Chevall. (+), *Chamaeme-*
lum fuscatum (Brot.) Vasc. (+).