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Effects of different management methods on the floral composition of pastures on Asiago plateau (NE Italy)

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SUMMARY – With the aim of learning more about the effects of supplementing the diet of grazing animals with food concentrates on the floral composition in mountain pastures, two neighbouring *malghe* were chosen in three different areas of the Asiago plateau. In the previous six years one of these *malghe* had been grazed by cattle which had been supplied concentrates and the other by animals that did not received the supplement. Based on 19 floral surveys done in the 6 *malghe*, it emerged that in the zone characterized by a mesophil climate and shallow soils, the use of concentrates increases the cover of species that are favoured by high nutrient contents in the soil, without increasing the pastoral value. Instead, in the areas with a fresher climate and deeper soils, the number of nitrophilous species increases with the use of concentrates.

Keywords: Mountain pastures, grazing management, floral richness, concentrated food.

RESUME *– "Effets de différentes méthodes de gestion sur la composition florale des parcours dans le Plateau d'Asiago (NE Italie)". L'effet de la supplémentation des régimes des animaux avec des concentrés sur la composition floristique dans les pâturages de montagne a été étudié dans trois régions différentes du plateau d'Asiago. Pendant les 6 dernières années l'un des pâturages avait été brouté par du bétail recevant du concentré, et l'autre par des animaux ne recevant pas de supplément. Sur la base des 19 relevés botaniques effectués dans 6* malghe*, il ressort que dans la zone caractérisée par un climat de mésophiles et des sols superficiels, l'usage des concentrés augmentait la couverture des espèces qui sont favorisées par une importante présence d'éléments nutritifs dans le sol sans augmenter la valeur pastorale de ces domaines. Dans les zones ayant un climat plus frais et des sols plus profonds, le nombre d'espèces nitrophiles augmentait avec l'usage de concentrés.*

Mots clés : *Pâtures de montagne, gestion pastorale, richesse en espèces, concentré.*

Introduction

Pastures, along with the meadows, forests, torrents and lakes, constitute an historical and essential component of the mountain landscape.

The way in which these biocoenoses have been used has been altered radically during the last century. Until the 1950s, transhumance was practised, and mountain pastures were widespread and intensively used during the summer months for grazing animals brought up from farms in the lowlands. The aim was to increase livestock production and to keep the farm fields for forage crops. This also removes the farmers from work in the cowsheds during the summer, to concentrate on haymaking. The mountain grazing also improved the health of the animals, which were confined for many months in not always very healthy cowsheds.

During the next forty years or so, as a result of the marked socio-economic changes taking place in mountain areas and the substantial changes in livestock management methods, many pastures were abandoned, and others were under-utilised or irregularly used. Traditional pasture management is nowadays only practised in limited areas, so many pastures lying below the tree line have been totally, or at least partially, re-colonised by forest vegetation.

In the last decade, there has been increasing awareness that pastures are environmentally good to be safeguarded, and interest in these biocoenoses has also been encouraged by EU funding for farmers (i.e. Council Regulation N° 1257/99 on Rural Development, Action 6). Despite this, the situation in the mountain pastures has not been improved. Many of the livestock breeders who

currently make use of mountain pastures, in order to avoid any decrease in the productivity of their highly-bred animals, supplement their diets with food concentrates. The pastures, therefore, continue to be re-colonised by the forest, and also suffer from phenomena of eutrophication (nutrient pollution).

To improve knowledge of the effects of this type of nutrition on the floral composition of mountain pastures, six *malghe* managed in two different ways were studied in three different areas of the Asiago plateau. This paper reports and discusses the results of this survey.

Material and methods

The study was carried out at the Asiago plateau (province of Vicenza, Veneto Pre-Alps, NE Italy) where six *malghe* (three couples of two neighbouring *malghe*) were identified in three different areas, one of which in the last 6 years had accommodated cattle also fed with concentrates and one in which cattle nutrition had been based exclusively on the pasture. The main characteristics of these *malghe* are given in Table 1.

The *malghe* Campo and Corno are located in the Southern part of the Asiago plateau, on the South-facing Pre-Alps near the Po Plain, whereas the other four are located in the central plateau, at the bottom of a glacial valley surrounded by hills which determine phenomena of thermal inversion. The first two *malghe* are, therefore, characterized by higher temperatures than the other four. On the contrary, the annual rainfall of the whole area is very similar: between 1,500 and 1,600 mm/year. The rainfall presents a sub-equinoctial distribution but with marked continental aspects. There are two maximum in June and October, average monthly rainfall of about 80 mm from December to March, and from April to November it is constantly over 100 mm.

Table 1. Main characteristics of the six *malghe*

Malghe	Campo	Corno	Ronchetto	I lotto Marcesina	IV lotto Marcesina	Marcesina di sopra
Municipality	Lusiana	Lusiana	Foza	Enego	Enego	Enego
Altitude	1,289	1,327	1,330	1,325	1,356	1,364
Rocky substrate	Calcareous rocks	Calcareous rocks	Calcareous moraine	Calcareous moraine	Calcareous moraine	Calcareous moraine
Soil	Cambisols	Cambisols	Leptosols	Leptosols	Leptosols	Leptosols
Natural vegetation	Beech wood	Beech wood	Xeric Spruce wood	Xeric Spruce wood	Xeric Spruce wood	Xeric Spruce wood
Pastures area ha	44,6	41,9	40	80	80	130
Soil pH	5,87±0,13	5,75±0,10	5,43±0,12	5,54±0,11	5,78	7,27±0,09
Soil organic matter %	22,70±0,69	20,51±1,49	20,50±0,79	21,85±0,27	22,50	35,43±4,83
Soil deep cm	6,88±1,61	8,13±0,52	27,00±6,41	16,67±1,91	49,75	26,38±5,26
Livestock units	65	60	25	75	80	125
Grazing period	01/06-30/09	01/06-30/09	01/06-30/09	01/06-30/09	01/06-30/09	01/06-30/09
Concentrate use	No	Yes	No	Yes	No	Yes

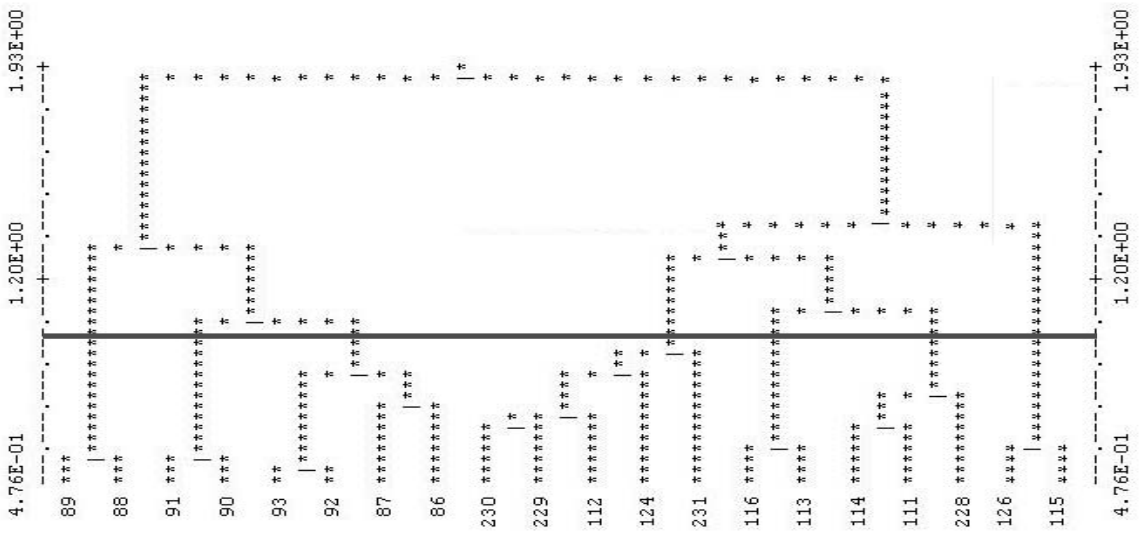
Nineteen floral surveys were done in the pastures of these *malghe*: 4 in the *malghe* Corno, 4 in Campo and Marcesina di Sopra, 3 in the *malghe* Ronchetto and in lotto I Marcesina and 2 in the IV lotto Marcesina. The method proposed by Braun-Blanquet (1964) was used, with % of cover being recorded instead of the cover index, on areas of 100 m^2 which present uniform vegetation. In order to count as many species as possible, each area was thoroughly analysed twice or three times during the 2002-2003 growing seasons. The species were named according to “Flora d’Italia” (Pignatti, 1982). The results of the repeated surveys were then averaged and statistically analysed using the Mulva-5 software (Wildi and Orloci, 1996), adopting the algorithm of minimum variance linkage and the Van der Maarel correlation coefficient. Soil samples were taken in each area to determine organic

matter content and pH, and the average soil depth was measured (mean of 4 depths using steel stake). The pastoral value was calculated according the index of Stählin (1970) and Klapp (1971).

Results and discussion

The dendrogram shows that the surveys are divided in two large groups, the first of which includes 8 surveys done in the two *malghe* located at the southern part of the Asiago plateau and characterized by very shallow soil. The second group includes the other 11 surveys of the *malghe* located in areas with deeper soils and cooler climate.

The first of these groups is classified into three clusters and the second one in four (Fig. 1). Based on an initial phyto-sociological analysis, the surveys of the three clusters in the first group (Table 2) seems referable, even if with features that differ from cluster to cluster, to the mountain form with *Alchemilla vulgaris* of the association *Festuco-Cynosuretum* Tx. in Bük 1942 (Oberdorfer, 1983). The three clusters are formed by surveys which include an average of between 38.0 (cluster 1) and 42.5 species (cluster 2) so are also quite similar in terms of this characteristic. It is also interesting to note that some species showed markedly different cover in the surveys of the individual clusters. In clusters 1 and 2, which include surveys of the *malga* Campo (without the use of concentrates), some species like *Anthoxanthum odoratum* (5.0-12.6%)*, Trifolium pratense* (2.3-2.8%) and *Alchemilla xanthochlora* (2.1-2.5%) show higher cover than in the other cluster.



Cluster	1		2		3				4					5		6			7	
Releves	89	88	91	90	93*	92*	87*	86*	230*	229*	112	124	231*	116*	113	114*	111	228*	126	115*
Malga	Ca	Ca	Ca	Ca	Co	Co	Co	Co	MdS	MdS	R	IV°M	MdS	I°M	R	I°M	R	MdS	IV°M	I°M
N° of species	42	34	39	46	39	40	52	38	59	51	40	31	43	39	40	44	54	52	31	40
Pastoral value	4,18	4,78	2,81	3,08	3,42	3,20	2,98	4,77	2,31	2,28	2,81	2,31	3,25	3,36	3,46	3,38	2,86	2,63	1,93	2,48
Graminaceae	32,8	31,8	48,5	53,5	46,8	50,0	41,5	47,2	40,8	41,6	51,1	58,5	31,6	49,4	53,5	47,5	38,6	48,1	68,9	65,9
Leguminosae	16,1	21,7	7,2	7,7	9,5	7,7	9,6	15,5	9,6	5,9	7,6	3,4	7,4	13,0	14,1	10,6	12,7	5,2	6,0	9,1

	Mean 1st group *		Mean 2nd group *	
N° of species	40,25±5,06	42,00±6,78	46,86±7,64	40,40±6,80
Pastoral value	3,71±0,93	3,59±0,81	2,81±0,50	2,68±0,58
Graminaceae	41,6±11,0	46,4±3,6	46,4±10,5	54,1±7,5
Leguminosae	13,2±7,0	10,5±3,4	8,7±2,7	8,76±3,96

* = concentrates food use

Fig. 1. Dendrogram, number of species, pastoral value, graminaceae and leguminosae % cover.

Table 2. Floral composition and species frequency in the 7 clusters

Cluster	1	2	3	4	5	6	7	Cluster	1	2	3	4	5	6	7
Number of releves	2	2	4	5	2	2	2	Number of releves	2	2	4	5	2	2	2
Differential species of association Festuco-Cynosuretum								**Species of class *Chenopodietea***							
Hieracium pilosella L.	1	2	1	2	1		1	Chenopodium bonus-henricus L.			1				
Potentilla erecta (L.) Rauschel				5	2	2	2	Carduus nutans L.				3			1
Briza media L.				2	1	2	2	Cirsium eriophorum (L.) Scop.				2		1	1
Nardus stricta L.		2	1	5	2	1	1	**Species of class Artemisietea**							
Differential species of mountain form with *Alchemilla vulgaris* of association Festuco-Cynosuretum								Urtica dioica L.	2	2		1			1
								Rumex alpinus L.	2			1			
Alchemilla xanthochlora Rothm.	2	2	1	3		1		Senecio cordatus Koch				1			
Carum carvi L.	2		1	3	2	2		Cruciata laevipes Opiz	2	2	1				
Differential species of high mountain form with *Crepis aurea* of association Festuco-Cynosuretum								Barbarea vulgaris R. Br.			1				
								Cirsium vulgare (Savi) Ten.			1				
Ranunculus venetus Huter	2		1	2				Cruciata glabra (L.) Ehrend.				3	1	2	2
Campanula scheuchzeri Vill.				4	2	1	2	Cirsium spinosissimum (L.) Scop.				1	1	1	
Species of alliance Cynosurion								**Species of class *Plantaginetea***							
Trifolium repens L.	2	2	1	5	2	2	2	Ranunculus repens L.	2	1	1				
Cynosurus cristatus L.			1					Poa annua L.	2	1					
Prunella vulgaris L.				1		1	1	Plantago major L.	2	2	1	2	1		
Leontodon autumnalis L.				1			1	Potentilla anserina L.				1			
Bellis perennis L.	1	1	1					**Other species**							
Veronica serpyllifolia L.	1	1	1	1	1			Carex caryophyllea La Tourr.				1			
Species of order Arrhenatheretalia								Euphorbia cyparissias L.				2	2	1	1
Achillea millefolium L.	2	2	1	5	1	2	2	Festuca valesiaca Schleicher			1				
Leucanthemum vulgare Lam.			1	3		2	1	Bromus erectus Hudson				1		1	
Leontodon hispidus L.		2	1	1	2	1	1	Hippocrepis comosa L.			1	4	2	2	2
Lotus corniculatus L.		2	1	4	2	2	2	Gentiana cruciata L.				1	1	2	1
Avenula pubescens (Hudson) Dumort.	2	2	1	1		1	1	Ranunculus bulbosus L.			1				
Dactylis glomerata L.		2	1	3		1	1	Galium verum L.				1	2	2	2
Taraxacum officinale Weber (aggregato)	2	2	1					Anthoxanthum odoratum L.	2	2	1	2			
Plantago media L.			1	5	2	2	2	Epilobium angustifolium L.				1			
Galium album Miller					1		1	Fragaria vesca L.				1		1	
Veronica chamaedrys L.	2	2	1	2	1	1	1	Rubus idaeus L.				1			
Crocus albiflorus Kit.	2	2	1	3	1	2		Lonicera coerulea L.				1			
Galium mollugo L.	2	2	1	2	1	1		Luzula sieberi Tausch ssp. sieberi				1			
Anthriscus sylvestris (L.) Hoffm.		1						Picea excelsa (Lam.) Link				2	1	2	2
Rhinanthus alectorolophus (Scop.) Pollich				2		2	1	Maianthemum bifolium (L.) Schmidt				1			
Stellaria graminea L.			1	3	1	2	1	Polygonatum verticillatum (L.) All.				1			
Narcissus poeticus L.	1		1					Symphytum tuberosum L.			1				
Lolium perenne L.			1					Helleborus viridis L. ssp. viridis	2	2	1				
Phleum alpinum L.		2	1	5	1	2	2	Brachypodium rupestre (Host) R. et S.							
Poa alpina L.	2	2	1	2				ssp. caespitosum (Host) Sch.				2	2	2	2
Cerastium fontanum Baumg.	2	2	1	3	1	2		Deschampsia caespitosa (L.) Beauv.	2		1	5	2	2	1
Differential and characteristics species of class *Molinio-Arrhenatheretea*								Lolium multiflorum Lam.			1				
								Molinia coerulea (L.) Moench				1			
Trifolium pratense L.	2	2	1	5	2	2	2	Poa supina Schrader			1				
Festuca rubra L. ssp. rubra		2		4	2	2	2	Carex flacca Schreber				3		1	
Polygonum bistorta L.			1	2				Centaurea nervosa Willd.	1	2	1	1			
Ranunculus acris L.		2	1	5	2	2	1	Centaurea nigrescens Willd. ssp. ramosa Gugler			1		1	1	1
Orchis maculata L.			1					Euphrasia stricta D. Wolff				4	2	2	
Poa pratensis L.	2	2	1					Galium rubrum L.				1			
Festuca pratensis Hudson				2			1	Juncus monanthos Jacq.				2			
Poa trivialis L.	2	2	1	3		2		Juniperus nana Willd.				1	1		
Colchicum autumnale L.				2		1	1	Knautia drymeia Heuffel ssp. intermedia	1						1
Plantago lanceolata L.	2	1	1	1	1	1	1	Melampyrum pratense L.	1		1				
Rhinanthus minor L.					1			Orchis mascula L.				1			
Rumex acetosa L.	2	2	1					Orchis sambucina L.	1		1				
Trollius europaeus L.				1		1		Petrorhagia saxifraga (L.) Link ssp. saxifraga				1			
Species of class *Nardo-Callunetea*								Salix glabra Scop.				1			
Geum montanum L.				5	2	1		Senecio abrotanifolius L.				1			
Hypericum maculatum Crantz	2	2	1	3	1	1	1	Senecio brachychaetus DC. limit. Cuf.			1				
Luzula campestris (L.) DC.	2	2	1	3				Vaccinium myrtillus L.				2			
Potentilla aurea L.		1	1	1	1	1		Valeriana officinalis L.	1	2		1			
Coeloglossum viride (L.) Hartm.				1				Veratrum album L.	1		1				
Arnica montana L.				1				Veronica officinalis L.		1				1	
Botrychium lunaria (L.) Swartz		1						Parnassia palustris L.				1	1	1	1
Carex leporina L.				1				Polygonum aviculare L.					1		
Species of class *Festuco-brometea*								Chenopodium bonus-henricus L.			1				
Carlina acaulis L.	2	2	1	3	2	2	2	Agropyron repens (L.) Beauv.				1			
Cirsium acaule (L.) Scop.	2	2	1	4	2	2	2	Rumex scutatus L.						1	
Pimpinella saxifraga L.				2	1	1		Agrostis tenuis Sibth.				5	2	2	2
Koeleria pyramidata (Lam.) Domin				3	1	2	1	Lotus alpinus (DC.) Schleicher	2		1				
Arabis hirsuta (L.) Scop.			1	1				Centaurea jacea L.				1			
Medicago lupulina L.					1	1		Luzula multiflora (Ehrh.) Lej.				1		1	
Species of class *Elyno- Seslerietea*								Thymus pulegioides L.		2	1	3	2	2	2
Pedicularis verticillata L.				2		1		Sedum acre L.		1	1		1		1
Anthyllis vulneraria L. ssp. alpestris (Kit.) Asch. et Gr.				3	2	1	1	Carex contigua Hoppe	1		1				
Acinos alpinus (L.) Moench				2				Myosotis sylvatica Hoffm.	1	2	1				
Erigeron alpinus L.				2	1	1		Ranunculus platanifolius L.					1	1	1
Potentilla crantzii (Crantz) Beck		1		1		1		Salix appendiculata Vill.						1	
Gentiana verna L.	1		1	1	1										
Carduus defloratus L.				1	1		1								
Hieracium bifidum Kit.			1	1											
Polygala alpestris Rchb.		2	1												
Danthonia decumbens (L.) DC.				1		1	1								
Calluna vulgaris (L.) Hull				2	1		1								
Gentiana clusii Perr. et Song. ssp. clusii				1											
Carex pallescens L.	1	2	1	2		1									
Polygala vulgaris L.				1											

Whereas in cluster 1 the species with greater cover than the other two are *Poa pratensis* (11.5 and 15.7%), *Poa trivialis* (9.2 and 9.4%), *Cruciata laevipes* (5.8 and 7.5%) and *Ranunculus repens* (5.7

and 7.5%), in cluster 2 *Avenula pubescens* (7.2 and 10.5%) and *Ranunculus acris* (7.0 and 8.0%) are much more widespread. A community, therefore, which appears to be at least partly responsible for the pastoral value of 4.48 in the first and 2.95 in the second. Finally, in cluster 3 – which includes only surveys of *malga* Corno (nutrition with concentrates) – the more widespread species than in the previous cluster are: *Poa alpina* (14.0-17.4%), *Phleum alpinum* (3.1-5.1%) and *Taraxacum officinale* (1.3-8.9%). Furthermore, *Cynosurus cristatus* and *Stellaria graminea* are only found in this cluster. The mean pastoral value is 3.59.

Comparison of these first three clusters shows that, while in *malga* Campo species with an early growing cycle are more common, probably an adaptation to the hot and sometimes dry summer, in *malga* Corno, where concentrates are fed to the animals, characteristic species of nutrient-rich soils are more common, such as *Poa alpina, Phleum alpinum* and *Cynosurus cristatus*, plus species that indicate a very irregular fertiliser distribution, such as *Taraxacum officinale* and *Stellaria graminea*.

The surveys that form the 4 clusters of the second survey group seem referable, even if with different levels of correspondence, to the high mountain form with *Crepis aurea* of the association *Festuco-Cynosuretum*, and thus represent different types of poor pastures. A situation that is also emphasised by the many species of the classes *Molinio-Arrhenatheretea*, *Elyno-Seslerietea*, *Nardo-Callunetea* and *Festuco-Brometea*.

Moreover, with the exception of cluster 6, which is formed by two surveys done in *malghe* where concentrates were administered, the other three are formed by surveys of both types of *malga*. As in the previous group of surveys, these 4 clusters differ not only by their different floral composition, but also by the different cover percentage of some species. In cluster 4, the 5 surveys are composed of 44.8 species on average, with *Nardus stricta* (17.8%), *Phleum alpinum* (3.7%), *Plantago media* (2.4%), and *Potentilla erecta* (2.1%) having higher cover values than in the other clusters. A community of species that, apart from *Phleum alpinum*, demonstrates that the surveys are of poor pastures, which is also confirmed by their lower pastoral value of 2.59 (±0.43). Cluster 5 is instead formed by two surveys which include 39 and 40 species, some of which present high cover values, such as *Festuca rubra* ssp. *rubra* (26.0 and 25.8%), *Agrostis tenuis* (13.0 and 5.9%), *Nardus stricta* (6.1 and 3.7%), *Hippocrepis comosa* (4.3 and 3.7%) and *Lotus corniculatus* (2.6 and 4.4%). Their pastoral values are 3.36 and 3.46, respectively. Cluster 6 includes two surveys composed of 44 and 52 species. The species with higher cover percentages than those observed in the other clusters are *Koeleria pyramidata* (11.3 and 11.7%), *Agrostis tenuis* (11.3 and 4.5%) and *Briza media* (5.3 and 2.6%). Their pastoral values correspond to 3.38 and 2.63, respectively. Lastly, cluster 7 includes surveys that probably correspond to a degraded form of *Festuco-Cynosuretum*, where *Brachypodium rupestre* ssp. *caespitosum* has a cover index of 45.3 and 30.4%, that of *Agrostis tenuis* ranges between 8.1 and 13.8%, and *Briza media* between 5.0 and 4.3%. These characteristics also justify the limited number of species (31 and 40) and their lower pastoral values (1.93 and 2.48).

Taking the second group of surveys as a whole, it does not seem possible to distinguish the surveys referable to the two types of management on the basis of the phyto-sociological analysis. Nevertheless, if the number of species included in the surveys is considered, it can be observed that more nitrophilous species are present (i.e., species of the classes *Artemisietea* and *Chenopodietea*). in the pastures where concentrates are supplied.

Conclusions

The floral surveys demonstrate that, in the areas characterised by a mesophyl climate and shallow soils, the use of concentrates in the livestock diet generally increases the cover of species which are favoured by high soil nutrient content, but does not alter the pastoral value. Instead, in the zones where the climate is fresher and the soils deeper, nitrophilous species are more frequent where concentrates are administered.

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