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SUMMARY – With the aim of improving knowledge on the effects of grazing by different animals (cattle and sheep) on the characteristics of mountain pastures, 19 floral surveys were conducted on two neighbouring *malghe* at two different areas of the Asiago plateau. In the previous 6 years one of each pair had been grazed by cattle and the other by sheep. The results of the surveys indicate that, while the fat pastures were not influenced by different grazing animals, the poor ones, referring to the high mountain form of the association *Festuco-Cynosuretum* with *Crepis aurea*, were richer in species when grazed by cattle and especially in Leguminosae

Key words: Mountain pastures, grazing, cattle, sheep, pasture characteristics.

RESUME *– "Effets du pâturage de différents animaux sur la composition florale des pâturages pré-alpins à Veneto (NE Italie)" Dans l'objectif d'améliorer la connaissance des effets du pâturage par des animaux différents (bovins et moutons) sur les caractéristiques de pâtures de montagne, deux* malghe *avoisinants dans deux régions différentes du plateau d'Asiago ont été choisis. Pendant les 6 dernières années un des* malghe *a été pâturé par les bovins et un autre par les moutons. Basés sur 19 relevés botaniques exécutés dans les* malghe*, les résultats indiquent que les pâtures riches n'ont pas été influencées par les animaux qui broutent tandis que les pâtures pauvres, comme la forme d'association de haute montagne de* Festuco Cynosuretum *avec* Crepis aurea*, quand elles ont été broutées par les bovins, étaient plus riches en espèces et, particulièrement, en Leguminosae.*

Mots-clés : *Pâtures de montagne, pâturage, bovins, moutons, caractéristiques des parcours*

Introduction

Mountain pastures are increasingly considered as an essential component of alpine areas, so it is worthwhile preserving those still in existence (i.e. Council Regulation (EC) N° 1257/99 on Rural Development, Action 6). To pursue this objective, it is essential to adopt sustainable management, which preserves the productive features of the plant community (quantity and quality, distribution throughout the grazing season, etc.), as well as the floral composition of the pastures. This should be based on knowledge of the nutritional needs and grazing habits of the animals as well as the effects of the grazing on the pastures features.

In order to contribute to the knowledge of the effects of grazing cattle or sheep on the floral composition of mountain pastures, floral surveys were done during 2002-2003 on two pairs of *malghe* at the Asiago plateau (province of Vicenza, Venetian Pre-alps, NE Italy) using the Braun-Blanquet method. Two of these malghe had been grazed by cattle and the adjacent two by sheep for at least the previous six years. The results are reported and discussed.

Materials and methods

The four studied *malghe* were: "Meletta Ristecco" and "Meletta Davanti" in the Gallio area, and "Montagnanuova" and "Slapeur" in the Foza area. The altitude of the *malghe* varied between 1628 m a.s.l. for "Meletta Ristecco" and "Slapeur" and 1724 m a.s.l. for "Montagnanuova" The rocky substrate of all the *malghe* is formed by "Calcari Grigi" of the upper Jurassic and "Rosso Ammonitico" of the middle and lower Jurassic. The soils of the steepest sloping areas and the higher altitude stations are Rendzic Leptosols, while all the others are Cambisols of varying depths.

Based on the Walter and Lieth (1960) climate diagram for Asiago (1045 m a.s.l.) and the inverse relationship between temperature and altitude (Accordi *et al.*, 1993), it can be inferred that the average annual temperature of the area is approx. 3.9 °C. Average annual rainfall is about 1700 mm of a sub-equinoctial character but with marked continental aspects, as implied by the presence of two maximums in June and October, low rainfall from December to March, and a monthly average well above 100 mm, from April to November. The forest vegetation growing near the 4 *malghe* means that it may be assumed that the forest type which would grows in these areas would be *Dentario pentaphylli-Fagetum sylvaticae* H. Mayer et Hofmann 1969, subass. *Fagetosum* Poldini et Nardini 1993.

The main characteristics of the 4 *malghe* are indicated in Table 1. Nineteen floral surveys were conducted: 12 in the *malghe* grazed by sheep and 7 in those grazed by cattle, using the Braun-Blanquet method (1964), but recording % cover instead of the cover index. The surveys were on areas of 100 m^2 that showed an uniform vegetation. With the aim of surveying the biggest number as possible of species, each area was thoroughly analysed two-three times during the 2002-2003 growing season.

Table 1. Main characteristics of the four malghe

Malga	Meletta Ristecco	Meletta Davanti	Montagnanova	Slapeur
Kind of animals	Cattle	Sheep	Cattle	Sheep
Altitude	1628	1693	1724	1628
Area (ha)	89.2	173.3	101.0	154.0
Soil pH	5.06±0,23	5.23±0,64	7.00±0,30	5.56±0,16
Soil organic matter (%)	30.17±5,73	28.26±10,73	51.05±5,61	26.87±3,50
Soil depth (cm)	18.50±5,54	11.63±4,47	16.83±6,68	13.54±5,31
Number of animals	80	840	65	480
Livestock Units (LU)	80	126	65	72
LU/ha	0.90	0.73	0.64	0.47
Grazing period	01 Jun - 30 Sept	01 Jun - 30 Sept	01 Jun - 30 Sept	01 Jun - 30 Sept

The species were named according to "Flora d'Italia" (Pignatti, 1982). The results from each area were averaged and cluster analysis was then performed using the Mulva-5 software (Wildi and Orloci, 1996), adopting the minimum variance linkage algorithm and the Van der Maarel correlation coefficient. Soil samples were taken from each area to determine organic matter content and pH. In each area the average depth of soil was measured (mean of 4 depths measured with a steel stake). The pastoral value was calculated according to the index of Stählin (1970) and Klapp (1971).

Results and discussion

The cluster analysis demonstrated that the 19 pastoral vegetations are referable to four different clusters (Fig. 1), each one formed by between 3 and 7 surveys. With the exception of cluster 4, which is formed by three surveys all done at *malga* Slapeur, the other 3 clusters include simultaneous floral surveys in *malghe* grazed by both cattle and sheep. It, therefore, appears that the two species of grazing animals have not determined marked differences in the floral composition of the pastures.

From the analysis of the dendrogram it is also possible to conclude that cluster 1 differs clearly from the other three, which are instead very similar to one another. The average floral composition of the seven surveys included in cluster 1 (Table 2) involved a large number of species belonging to four classes: *Molinio-Arrhenatheretea* Tx. 1937 (in Tx. et Prsg. 1951), *Nardo-Callunetea* Prsg. 1952, *Elyno-Seslerietea* Br.-Bl. 1948 and *Festuco-Brometea* Br.-Bl. et Tx. (in Br.-Bl. 1949). Closer examination reveals that there are:

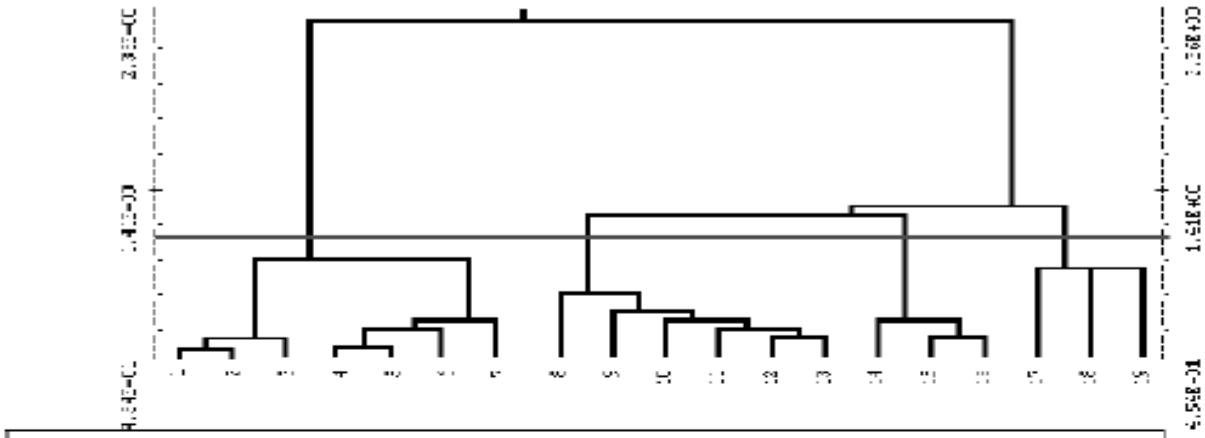
(i) Numerous characteristic and differential species of the class *Molinio-Arrhenatheretea* and of the order *Arrhenatheretalia* Pawloski 1928 (Oberdorfer 1983);

(ii) *Trifolium repens* and *Lolium perenne*, considered characteristic species of the alliance *Cynosurion* Tx. 1947;

(iii) *Hieracium pilosella*, *Potentilla erecta* and *Nardus stricta*, indicated as differential species of the association *Festuco-Cynosuretum* Tx. in Bük, 1942;

(iv) *Carum carvi*, *Ranunculus venetus* (group of *R. montanus* Willd., Pignatti, 1982), *Campanula scheuchzerii* and *Alchemilla xanthochlora*, considered differential species of the high mountain form of the association *Festuco-Cynosuretum*.

Based on these considerations, although *Crepis aurea* is absent (as it is over much of the Veneto Pre-Alps), it seems possible to refer the seven surveys to the high mountain form with *Crepis aurea* of the association *Festuco-Cynosuretum*. These are therefore poor pastures, which is also testified by the presence of many low species, such as *Carlina acaulis*, *Cirsium acaule*, *Ajuga reptans* and *Thymus pulegioides*, and the high cover of *Nardus stricta* and *Agrostis tenuis*, which are often complementary.



Cluster	1							2						3			4		
Releves	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Malga	Mn	Md	Md*	Mr	Md*	Sl*	Mr	Sl*	Mn	Sl*	Md*	Md*	Mr	Mn	Md*	Mr	Sl*	Sl*	Sl*
N° of species	27	27	40	38	34	26	36	36	26	39	32	30	30	25	20	20	27	23	39
Pastoral value	3,08	2,68	2,61	2,84	2,96	2,76	3,48	4,74	4,14	3,08	3,60	4,13	3,89	3,36	4,62	4,39	4,29	2,53	2,40
Graminaceae %	67,90	76,68	59,75	63,78	57,79	69,39	63,94	64,19	74,82	55,66	60,05	61,90	57,96	50,56	65,53	53,97	61,90	65,52	54,82
Leguminosae %	2,54	4,14	7,76	6,56	6,33	1,61	7,06	5,16	4,24	4,66	7,30	8,57	9,80	9,52	12,82	12,70	6,19	3,02	6,26
Agrostis tenuis	6,27	12,90	10,46	21,87	27,57	20,58	33,46	19,02	8,07	21,89	12,66	14,29	20,41	6,78	3,60	11,90	19,05		3,13
Nardus stricta	37,64	41,94	55,79	30,61	24,12	24,69	13,38		5,66		5,06							5,17	
Poa alpina	3,14							15,94	28,25	8,78	16,88	16,19	16,33	28,88	48,17	35,71			
Festuca rubra	10,04	9,68	5,58	3,84	0,69	12,35	7,48	7,97	24,21	13,13	12,66	17,14	14,69				1,90	12,93	15,66
Deschampsia caespitosa	0,13	1,29	0,70	1,46		0,41		2,39	2,42		2,53	1,90	2,45	1,44	2,16	0,79	3,81	38,79	
Festuca pratensis																	23,81		
Sesleria varia																			27,41

Fig. 1. No. of species, pastoral value, % cover of graminaceae, leguminosae and the more common species. Mn: Montagnanuova; Md: Meletta davanti; Sl: Slapeur; Mr: Meletta Ristecco; *: malghe with sheep.

Table 2. Frequency of the species in the different clusters

Cluster N°	1	2	3	4		
Releves				**a**	**b**	**c**
Differential species of association *Festuco-Cynosuretum*						
Potentilla erecta (L.) Rauschel	V	II			•	•
Nardus stricta L.	V	II			•	
Hieracium pilosella L.	III	III				•
Stellaria graminea L.	I	III				
Differential species of high mountain form with *Crepis aurea* of association *Festuco-Cynosuretum*						
Carum carvi L.	V	V	V	•	•	•
Campanula scheuchzeri Vill.	V	V		•	•	•
Alchemilla xanthochlora Rothm.	I	I	II			
Ranunculus venetus Huter	II					
Euphrasia rostkoviana Hayne		I				
Species of alliance *Cynosurion*						
Trifolium repens L.	V	IV	V	•	•	
Leontodon autumnalis L.		II	IV			
Phleum pratense L.		I	II			
Lolium perenne L.	I					
Species of alliance *Poion alpinae* and of the association *Crepido-Festucetum rubrae*						
Phleum alpinum L.	V	V	V	•	•	
Poa alpina L.	I	V	V			•
Cerastium fontanum Baumg.	II	V	IV		•	
Species of order *Arrhenatheretalia*						•
Lotus corniculatus L.	V	V		•	•	•
Achillea millefolium L.	V	IV	V	•	•	
Crocus albiflorus Kit.	V	V			•	
Veronica chamaedrys L.	III	IV	IV	•	•	
Galium album Miller	II	III		•		•
Plantago media L.	III	III				
Taraxacum officinale Weber (aggregate)	I	V	V			
Dactylis glomerata L.		I	II			
Leontodon hispidus L.	II					
Leucanthemum vulgare Lam.	I	I				•
Avenula pubescens (Hudson) Dumort.		I				•
Galium mollugo L.	I					
Geranium pratense L.				•		
Differential and characteristics species of class *Molinio-Arrhenatheretea*						
Trifolium pratense L.	V	V	V		•	•
Festuca rubra L. ssp. *rubra*	V	V		•	•	•
Polygonum bistorta L.	V	III	V	•	•	•
Ranunculus acris L.	IV	V	V	•	•	
Orchis maculata L.	I					
Poa pratensis L.			II			
Festuca pratensis Hudson				•		
Species of class *Nardo-Callunetea*						
Geum montanum L.	V	V		•	•	•
Hypericum maculatum Crantz	IV	II			•	•
Luzula campestris (L.) DC.	III	I				•
Potentilla aurea L.	II	I			•	•
Coeloglossum viride (L.) Hartm.	I	I				
Arnica montana L.	I					
Botrychium lunaria (L.) Swartz	I					
Carex leporina L.	I					
Species of class *Festuco-brometea*						
Carlina acaulis L.	V	III			•	•
Cirsium acaule (L.) Scop.	III	V	II		•	•
Pimpinella saxifraga L.	III	I				
Koeleria pyramidata (Lam.) Domin	III					•
Gentianella germanica (Willd.) Warburg	I	II				
Arabis hirsuta (L.) Scop.	I					
Medicago lupulina L.				•		

Cluster N°	1	2	3	4		
Releves				**a**	**b**	**c**
Species of class *Elyno- Seslerietea*						
Pedicularis verticillata L.	IV	V				•
Anthyllis vulneraria L. ssp. *alpestris* (Kit.) Asch. et Gr.	II	III				•
Acinos alpinus (L.) Moench	I	II			•	•
Erigeron alpinus L.	II	I				•
Potentilla crantzii (Crantz) Beck	I	II				
Gentiana verna L.		II				•
Carex sempervirens Vill.		I				•
Cerastium alpinum L.	I					
*Sesleria varia (*Jacq.) Wettst.						•
Species of class *Chenopodietea*						
Capsella bursa pastoris (L.) Medicus			II			
Chenopodium bonus-henricus L.			IV	•		
Carduus nutans L.	V	V	IV	•	•	•
Cirsium eriophorum (L.) Scop.	IV	I				
Species of class *Artemisietea*						
Urtica dioica L.		II	IV	•		
Lamium album L.				•		
Rumex alpinus L.				•		
Senecio cordatus Koch		V	V	•		
Cruciata laevipes Opiz	III	II	IV	•	•	
Barbarea vulgaris R. Br.			II			
Species of class *Plantaginetea*						
Ranunculus repens L.		II			•	
Poa annua L.	I	IV	II	•		
Other species						
Agrostis tenuis Sibth.	V	V	V	•		•
Deschampsia caespitosa (L.) Beauv.	IV	V	V	•	•	
Euphrasia stricta D. Wolff	IV	III			•	•
Thymus pulegioides L.	III	II		•	•	
Daphne mezereum L.	III	II				•
Parnassia palustris L.	III	II				
Centaurea nervosa Willd.	I	I			•	
Ajuga reptans L.	IV					
Brachypodium rupestre (Host) R. et S. ssp. *caespitosum* (Host) Sch.	III					
Carex ornithopoda Willd.	II					
Soldanella alpina L.	II					
Carex flava L.	I					
Pinguicula vulgaris L.	I					
Lycopodium annotinum L.	I					
Carex contigua Hoppe	I					
Anthoxanthum odoratum L.	I					
Plantago major L.		I	V			
Stachys alopecuros (L.) Bentham ssp. *jacquinii* (Godron) Vollmann		II				•
Carex sempervirens Vill.		I				•
Horminum pyrenaicum L.		I				•
Juncus monanthos Jacq.		I				•
Carex flacca Schreber		I				
Myosotis alpestris F. W. Schmidt		I				
Polygonum aviculare L.		I				
Homogyne alpina (L.) Cass.		I				
Picea excelsa (Lam.) Link		I				
Cerastium arvense L.			II			
Poa supina Schrader			II			
Cirsium arvense (L.) Scop.			II			
Senecio cacaliaster Lam.			II			
Galeopsis speciosa Miller					•	
Listera ovata (L.) R.Br.						•
Salix glabra Scop.						•
Silene dioica (L.) Clairv.						•
Ranunculus platanifolius L.						•

Analysis of the surveys in cluster 1 shows that, whereas the four surveys of the *malghe* grazed by sheep are composed of 28.5 species on average, they have an average pastoral value of 2.75 with Graminaceae and Leguminosae covers equal to 65.90% and 3.66%, respectively. The three surveys conducted on areas grazed by cattle, instead, included 38 species, with a pastoral value of 3.13, and Graminaceae and Leguminosae covers of 65.20% and 7.13%, respectively.

In general, it appears that cattle, which is perhaps less selective towards grasses than sheep, can guarantee a greater floral richness and higher pastoral value.

Cluster 2 shows a similar number of characteristic and differential species of the class *Molinio-Arrhenatheretea* and the order *Arrhenatheretalia* tan cluster 1 but having these species a clearly higher frequency. The species of the classes *Nardo-Callunetea* and *Festuco-Brometea* in this cluster are less abundant than in the previous cluster and have a much lower frequency.

In cluster 2, the three species *Poa alpina*, *Phleum alpinum* and *Cerastium fontanum* are present in almost all of the surveys, and the first two, together with *Agrostis tenuis* and *Festuca rubra* ssp. *rubra*, always show high cover percentages. Some species of the classes *Chenopodietea*, *Artemisietea* and *Plantaginetea* are also included in this cluster. In general, it seems possible to attribute the seven surveys of cluster 2 to the alliance *Poion alpinae* Oberd. 1950 and the association *Crepido-Festucetum rubrae* Lüdi 1948. It is, thus, a vegetation of fat pastures, which are usually located on flat areas and thus better than those included in the cluster 1 communities. Besides, animals spend more time in these areas.

Comparison of the surveys in this cluster demonstrates that there are no marked differences between the *malghe* grazed by cattle and those grazed by sheep, either in terms of species number per survey or in the pastoral value of the pastures. The fat pastures do not appear to be affected by the type of animal using them, probably because, with their specific characteristics, they are used in the same way by both cattle and sheep.

Cluster 3 is composed by three surveys which include species of the class *Molinio-Arrhenatheretea*, order *Arrhenatheretalia* and alliances *Cynosurion* and *Poion alpinae*. Between these last, *Poa alpina* stands out, as it has cover indexes of between 29 and 43%. There are also various characteristic species of the classes *Chenopodietea*, *Artemisietea* and *Plantaginetea*. It seems possible to refer these surveys to a nitrophilous form of the association *Crepido-Festucetum rubrae*, also because this would justify the absence of *Festuca rubra*. A further confirmation that this is a vegetation with a high nutrient availability is that the average number of species in this plant community is 22, and, therefore, fairly low. On the other hand, its pastoral value is equal to that of the previous cluster. Analysis of these three surveys does not, in any way, differentiate the ones grazed by cattle from those grazed by sheep.

Lastly, cluster 4 is composed by three surveys, as mentioned above, all referring to a *malga* grazed by sheep. These surveys differ from those in the previous clusters, but also from one another. Each one has a dominant species, i.e., *Festuca pratensis*, *Deschampsia caespitosa* or *Sesleria varia*. The accompanying species also differ, at least partly. In fact, together with *Festuca pratensis* and various species of the class *Molinio-Arrhenatheretea*, there are mainly species of the classes *Chenopodietea* and *Artemisietea*, with *Deschampsia caespitosa* and species of the class *Molinio-Arrhenatheretea*, species of the class *Nardo-Callunetea,* with *Sesleria varia* and species of the class *Molinio-Arrhenatheretea. Some* species of the class *Elyno-Seslerietea* are found and some of the class *Nardo-Callunetea*.

Obviously, as a result of these different situations, the floral richness and pastoral value of the individual pastures also varied. While 27-28 species are present with *Festuca pratensis* and *Deschampsia caespitosa*, this number increases to 39 with *Sesleria varia*. Where *Festuca pratensis* is present the pastoral value is 4.29, whereas this parameter is around 2.50 where the other two Graminaceae grow.

Conclusions

In the areas where the surveys were done it was observed that fat pastures, referable to the

association *Crepido-Festucetum rubrae,* are not affected by different grazing animals, probably because they are grazed in the same way by both cattle and sheep. On the contrary, the poor pastures, referable to the high mountain form of the association *Festuco-Cynosuretum* with *Crepis aurea*, include a larger number of species and have a higher pastoral value when grazed by cattle than those in the same plant community when grazed by sheep.

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