

THE EVOLUTION OF *ARNICA MONTANA* L. GRASSLANDS DEPENDING ON THE PERFORMED MANAGEMENT (APUSENI MOUNTAINS, ROMANIA)

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Abstract

In Gârda de Sus commune there is unfolding research concerning the influence of the use system upon *Arnica montana* L. grasslands, more precisely, the manner in which the fertilisation actions are performed and how they influence the sward's composition. The existence of *A. montana* L. meadows is the result of performing a long lasting traditional management of extensive type. These oligotrophic grasslands are only organic fertilised, using mainly the stable manure. The most landowners fertilise the *Arnica* grasslands in a regular cycle: annually most of the times, and rarely once at two or three years. The exploitation only through grazing produces the strong installation of some species like: *Vaccinium myrtillus* L., *Vaccinium vitis-idaea* L., *Luzula luzuloides* Lam., *Deschampsia flexuosa* L. etc. The application of maintenance works and use through mowing favours the spreading of some species with forage value: *Agrostis capillaris* L., *Festuca rubra* L., *Trisetum flavescens* L., *Trifolium pratense* L., etc., as well as some without forage value: *Centaurea pseudophrygia* C.A. Meyer, *Euphrasia officinalis* L., *Gymnadenia conopsea* L., *Hieracium aurantiacum* L. etc. The *Arnica montana* L. populations, from the number of individuals point of view, are poorly influenced by these two systems practicing, being present in both cases with considerable cover.

Key words: *Arnica montana* L., grassland use, maintenance activities, fertilization, species composition

Romania is one of the main source countries of dried *Arnica montana* L. flower heads processed in Central Europe (Kathe et al., 2004). *Arnica montana* L. occurs in *Nardus stricta* L. grasslands on siliceous soils in mountains areas. This habitat type (Code 6230) is listed in the EU-FFH-directive (92/43) and the species *Arnica montana* is listed in Annex V (92/43) (Michler et al., 2005).

Agriculture formed traditional rural landscapes in the studied region. Highly diverse and traditionally managed meadows can still be found in the Apuseni Mountains (Transylvania, Romania). The habitats are species rich with a total of 143 species identified (Michler, Reif, 2003). The habitats are threatened by conversion to more intensive agriculture or by stopping the agricultural use.

MATERIAL AND METHOD

Our studies have been carried out in the perimeter of Gârda de Sus village from the Apuseni Mountains, in the period 2005-2006. The research activity took place within the framework of the project called Conservation of Eastern Medicinal Plants: *Arnica montana* L. in Romania (www.arnica-montana.ro). In this work 10 polygons will be analyzed regarding not only the applied management, but also the floristic composition. 5 polygons from the Southern area and 5 polygons from the Northern area have been taken into

consideration, because the Southern region is placed on siliceous substratum and the Northern one is placed on limestone substratum. The research points were chosen depending on the presence of arnica within the sward, one of the points having no arnica individuals. The information regarding the management of meadows with *Arnica montana* L. have been obtained after discussions with the landowners.

The productivity of the grasslands was studied by cutting the grass at 5 cm height on 1m² and then weighed. For the determination of the floristic composition has been delimited a square with the web of 5 meters, where has been applied the Braun-Blanquet modified method and in the middle of the square it has been worked with the metric frame. It's been used this combined research method, because on 25 square meters it can be better determined the plant biodiversity, than on a square meter and the species coverage can be more precisely caught using the metric frame (1m²).

The Braun-Blanquet method involves identifying a specific area (called a "plot" or "quadrat"), identifying all species represented in that area, and then assigning each a code based on its contribution to the total area. It is used to survey large areas very rapidly. One consists of a plus sign and a series of numbers from 1 to 5 denoting both the numbers of species and the proportion of the area covered by that species, ranging from + (sparse and covering a small area) to 5 (covering more than 75% of the area). This

scale can be modified in order to be more accurate as there are more subdivisions of the original scale. The scale used for 25 m² plots is explained in table 1.

RESULTS AND DISCUSSIONS

The management of the Arnica meadows differs rather much from the Northern area to the Southern area of the commune. The maintenance tasks performed on these meadows are: gathering rocks, anthills' destroying, fighting against wooden vegetation and weeds and fertilization which is the most important one. The most important maintenance work is the fertilization, which is done only with manure. In the Southern area, the maintenance activities are being performed with less intensity, comparing to the Northern area (table 2).

After discussing with landowners, we concluded that the fertilisation of oligotrophic grasslands with Arnica is only organic, using mainly the stable manure. Most of the landowners fertilize the Arnica grasslands in a regular cycle: annually in most cases, and rarely once at two or three years. In the Southern area, these meadows are not being fertilized in most of the cases or a reduced quantity (red.) is used, whereas in the Northern area, the quantities are comprised between 3 and 20 t ha⁻¹ manure, being applied in spring (spr.) and autumn (aut.). In the Southern area, in general, the grasslands are exploited through a continuous (cont.) or a summer-autumn (sum., aut.) grazing, whereas, in North, it is being practiced only in autumn. The exploitation through mowing or through a mixed system is not practiced in the Southern area, while, in North these two systems are very frequent. Here, the mowing takes place from the end of July (Jul.) until the beginning of August (Aug.).

The productivity of the Arnica grasslands it was measured as dry matter and it ranged between 0.61 to 1.14 D.M. t/ha in the Southern area and between 0.79 to 1.73 D.M. t/ha in the Northern area. Similar to Apuseni Mountains are subalpine grassland (*Festuca rubra* L. type) in Oriental Carpathians where Buzdugan et. al. (1986) determined the value 2.2 – 2.6 t/ha D.M., in the Blana – Bucegi Mountains (*Nardus stricta* L. type) where Marușca et. al. (2010) determined a mean value 1.42 t/ha D.M. and in Bulgaria at 900 – 1100 meters elevation (*Agrostis capillaris* L. – *Festuca pallens* Host. type), Todorova et al. (2003) determined a mean value 3.35 t/ha D.M..

The floristic composition is very much stricken by the applied management. *Agrostis capillaris* L. is less frequent in the south, comparing to the north, where it gets up to the

coverage of 19.00%. *Alchemilla vulgaris* L. is not present in the samples from the Southern area, but only in the samples from the north, reaching 12.75%. The *Arnica montana* L. species is found in both regions. *Cynosurus cristatus* L. appears only in the samples from the Northern region. *Centaurea pseudophrygia* C.A. Meyer and *Cerastium holosteoides* L. are found only in case of organic fertilizers application. *Euphrasia officinalis* L. is present only in the samples from the Northern area. The *Festuca rubra* L. specie has large spreading in the Northern area. *Hieracium aurantiacum* L. is favoured by the application of larger quantities of manure. *Leucanthemum vulgare* L. behaves similar to *Lotus corniculatus* L. and has a very small spreading in the Southern area, comparing to the Northern area. *Pimpinella major* L. and *Plantago lanceolata* L. behave likewise. *Polygala vulgaris* L. and *Prunella vulgaris* L. are present only in the samples from the north. The same presence is ascertained for the next species: *Rhinanthus glaber* L. A., *Rhinanthus minor* L. and *Ranunculus acris* L.. *Trifolium pratense* L. and *Trifolium repens* L. are favoured by the usage way met in the Northern region. *Vaccinium myrtillus* L. and *Vaccinium vitis-idaea* L. are present with a significant coverage in the Southern area and in the Northern area they have a very small coverage. *Veratrum album* L. and *Viola declinata* Waldst et Kit. appear only in the Northern region.

The floristic composition is strongly influenced by the management applied to grasslands. The *Poaceae* participation in the sward is considerably reduced in the Southern area (1.05-10.3%), comparative to the Northern area, where their participation reaches up to 34.75%. The *Fabaceae* are in the same situation, in most of the floristic studies in the Southern area are not being present, and in the Northern area they overtake up to 20%. The *Cyperaceae* and *Juncaceae* (other *Poales*) have a quite reduced cover in both areas of the commune. The plants from other botanical families (POBF) show a larger presence in both areas, their cover being comprised between 45.7 and 60.85% in South, respectively 37.25 – 94.4% in North.

The number of species per 1 m² is comprised between 10 and 15 in the Southern area and clearly superior is the number in the Northern area, where it ranges between 28 and 39. The same situation is registered when we refer to 25 m², the number ranging between 14 and 30 in the Southern area and between 39 and 53 in the Northern area. In Sudeten Mountains (Poland) which is a region important for agriculture and tourism, Biala and Zyskowska (2004) found an average number of 18 species per 25 m² varying from 5 to 42.

Table 1

The management and cover of species families within *Arnica montana* L. grasslands in two areas of Gârda de Sus commune

Area	Southern area					Northern area					
Parcel number	4004	4048	4057	4072	4073	11	26	30	45	52	
Locality	Valea Bucinișului	Biharia	Biharia	Biharia	Biharia	Marocu	Marocu	Valea Gârda Seaca	Ocoale	Ocoale	
Altitude m ASL	1014	1200	1250	860	880			1216			
Expozition	335	335	200			320	45	300	220	240	
Soil thickness (cm)	12	9	8	7	5	20	10	15	<20	12	
Slope (degrees)	32	11	25	21	26	15	17	7	7	6	
Management											
Maintenance activities	no	yes	yes	yes	no	yes	yes	yes	yes	yes	
Fertilization – quantity (t)	no	red.	no	red.	no	5-6	3-5	12-16	16-17	16-20	
Fertilization -time	no	spr., aut.	no	spr., aut.	no	spr., aut.	spr.	spr.	spr.	spr., aut.	
Grazing	cont.	sum., aut.	sum.	cont.	cont.	aut.	aut.	aut.	no	aut.	
Mowing	no	no	no	no	no	Aug.	Aug.	Jul.	Jul.	Aug.	
Mixed use	no	no	no	no	no	yes	yes	yes	no	yes	
Yield (g m ⁻²)	520	469	371	279	487	364	552	642	361	790	
Species					Frequency (per 25 m ⁻²)					Frequency (per 25 m ⁻²)	
<i>Agrostis capillaris</i> L.	0,25				2	2,00	10,00	19,00	7,00	8,25	5
<i>Anthoxanthum odoratum</i> L.		0,5	0,3	0,6	0,3	4	3,00	0,25	1,50	1,50	5
<i>Cynosurus cristatus</i> L.					0			0,75		19,50	4
<i>Dactylis glomerata</i> L.					0						1
<i>Danthonia decumbens</i> L.					1				0,25		1
<i>Deschampsia flexuosa</i> L.	7	5,5	10	2	0,75	5					0
<i>Festuca rubra</i> L.		0,75		0,2		4	4,00	14,00	6,00	8,75	5
<i>Nardus stricta</i> L.				0,4		2		0,75	2,50		2
<i>Phleum alpinum</i> L.					0						1
<i>Trisetum flavescens</i> L.					0		1,50			1,00	2
<i>Carex pallescens</i> L.			0,75	0,15	0,4	4		3,00	1,00		3
<i>Juncus inflexus</i> L.					0						1
<i>Luzula campestris</i> agg. L.					0	1,75	2,75	0,25	2,75	1,00	5
<i>Luzula luzulina</i> Vill.					0						1
<i>Luzula luzuloides</i> Lam.		0,4	2	0,5	0,1	4					1
<i>Lotus corniculatus</i> agg. L.					1		11,00	3,00	0,20	5,00	5
<i>Trifolium campestre</i> Schreber.					0						1
<i>Trifolium pratense</i> L.					0	1,00	5,50	0,25		1,75	5
<i>Trifolium repens</i> L.					0		4,00	0,50	0,75	3,00	4
<i>Vicia cracca</i> L.					0						1
<i>Acer pseudoplatanus</i> L.					0				0,20		1
<i>Achillea distans</i> Waldst.et Kit.ex Willd					0,1	2		0,20	2,50	1,00	3
<i>Achillea millefolium</i> L.										4,50	1
<i>Ajuga genevensis</i> L.					0		0,75				3
<i>Alchemilla vulgaris</i> agg. L.					0		3,00	12,75		1,50	5
<i>Anemone nemorosa</i> L.		0,22			2	0,25	0,75				3
<i>Antennaria dioica</i> L.			2	0,2	1,25	3	0,10				1
<i>Anthyllis vulneraria</i> L.					0	1,00					2
<i>Aposeris foetida</i> L.					0						2
<i>Arnica montana</i> L.	4	5,5	14	2	27	5	26,00	6,75	2,50	7,00	5
<i>Astrantia major</i> L.					0						1
<i>Botrychium lunaria</i> L.					0						1
<i>Briza media</i> L.					0	3,25					2
<i>Campanula patula</i> agg. L.					1	0,20					2
<i>Campanula serrata</i> Kit.	0,1			0,3	2						1
<i>Cardaminopsis halleri</i> L.					0	0,20	0,50				2
<i>Carlina acaulis</i> L.					2						0
<i>Carum carvi</i> L.					0						1
<i>Centaurea mollis</i> Waldst. et Kit.					0	2,50					1

Area	Southern area						Northern area					
<i>Centaurea pseudophrygia</i> C.A.Meyer.						1			5,50	0,75	1,00	4
<i>Cerastium holosteoides</i> Fries. ampl. Hyl.						0	0,50	1,00		0,20		5
<i>Cirsium erisithales</i> Jacq.						0	2,25					1
<i>Colchicum autumnale</i> L.						0						3
<i>Crocus vernus</i> L.		0,75			0,2	3	5,00	1,00		0,20		3
<i>Dactylorhiza majalis</i> Reichenb.						0	1,00			0,50		2
<i>Euphrasia officinalis</i> L.						0	15,75	1,75	2,00		1,00	4
<i>Galium album</i> Miller.						0						2
<i>Genistella sagittalis</i> L.				1,25		3						0
<i>Gentiana asclepiadea</i> L.						0						1
<i>Gentianella lutescens</i> Velen.						0	1,25	0,75			0,50	3
<i>Gnaphalium sylvaticum</i> L.						0			0,20			4
<i>Gymnadenia conopsea</i> L.						0	0,75					3
<i>Hieracium aurantiacum</i> L.						0	0,50	0,50		0,50	0,75	5
<i>Hieracium murorum</i> L.	3					1				1,00		1
<i>Hieracium pilosella</i> L.			0,5			2		0,75		5,00		3
<i>Homogyne alpina</i> L.						1						0
<i>Hypericum maculatum</i> agg. Crantz.	1				0,9	4		1,50	0,50		4,50	2
<i>Juniperus sibirica</i> L.						1						0
<i>Knautia dipsacifolia</i> Lode in Burgsd.						0		2,25			6,00	4
<i>Laserpitium krapfii</i> Crantz.				3,75		2						0
<i>Leucanthemum vulgare</i> Lam.						2	0,75	0,50	1,75	0,50		5
<i>Linum catharticum</i> L.						0	0,25	0,50				3
<i>Lycopodium clavatum</i> L.	1					2						0
<i>Lysimachia vulgaris</i> L.						0						0
<i>Melampyrum sylvaticum</i> L.						1						0
<i>Picea abies</i> L.				1,75	0,2	3				0,20		1
<i>Pimpinella major</i> L.						0	2,00	2,00	0,75		5,00	5
<i>Plantago lanceolata</i> L.						1		1,25	4,00		1,50	5
<i>Plantago major</i> L.						0						2
<i>Plantago media</i> L.						0						2
<i>Populus tremula</i> L.						1						0
<i>Polygala amarella</i> Crantz						0		2,00				2
<i>Polygala vulgaris</i> L.						3		1,50	1,50	0,50		4
<i>Polygonum bistorta</i> L.						0						1
<i>Potentilla erecta</i> L.	5	9,5	8	2,5	1,5	5		0,25	11,00	21,00	2,00	4
<i>Primula veris</i> L.						0	0,75					2
<i>Prunella vulgaris</i> L.						0		0,50	0,50	0,25		3
<i>Pseudorchis albida</i> L.	0,25					1		0,10			0,25	2
<i>Ranunculus acris</i> L.						0	0,50	1,00	0,50		4,00	4
<i>Ranunculus auricomus</i> L.						0						1
<i>Rhinanthus glaber</i> Lam.						0						1
<i>Rhinanthus minor</i> L.						0	1,50	1,00	0,50		7,00	4
<i>Rumex acetosa</i> L.						1	0,25	1,00				4
<i>Rumex acetosela</i> L.						1						0
<i>Salix caprea</i> L.						1					+	0
<i>Scabiosa columbaria</i> L.						0						1
<i>Scorzonera rosea</i> Waldst.et Kit.						1			1,25		0,50	2
<i>Silene nutans</i> L.						0						2
<i>Silene vulgaris</i> Moench.			0,2			1						0
<i>Soldanella hungarica</i> Simonkai.						0	1,50	0,20				3
<i>Stellaria graminea</i> L.			1			1	1,75		0,25		0,75	5
<i>Thesium alpinum</i> L.						1						0
<i>Thymus pulegioides</i> L.			3	0,1	0,2	4	12,00	3,25		3,50		5

Area	Southern area						Northern area					
<i>Traunsteinera globosa</i> L.						0	0,25					1
<i>Trollius europaeus</i> L.						0	9,00		2,50		0,20	4
<i>Vaccinium myrtillus</i> L.	30	21	10	35	23	5	1,00			2,50		2
<i>Vaccinium vitis-idaea</i> L.	6	12	7	1,5	5,25	5						0
<i>Veratrum album</i> L.						0	1,50	0,25	0,20	0,50		5
<i>Verbascum nigrum</i> L.						1						0
<i>Veronica chamaedris</i> L.						0		0,10			1,50	4
<i>Veronica officinalis</i> L.						3						1
<i>Veronica serpyllifolia</i> L.						0						1
<i>Viola canina</i> L.						0				0,75		1
<i>Viola declinata</i> Waldst. e Kit.						0	1,00	0,50			2,75	4
Species no (per 1 m ⁻²)	11	10	13	15	15		35	39	28	28	30	
Species no (per 25 m ⁻²)	14	16	20	30	26		52	53	39	46	47	
Herbaceous layer cover (%)	55	55	50	50	60		95	80	60	85	55	
Moss layer cover (%)	80	45	10	65	40		65	20	55	30	5	
Total vegetation cover (%)	98	80	55	95	70		97	97	90	70	87	

CONCLUSIONS

In general, the *Arnica montana* habitats in Gârda de Sus commune show a high plant biodiversity due to traditional management activities undertaken on these mountainous grasslands.

By performing the different management on grasslands in Gârda de Sus commune, it generates considerable changes within the canopy's species composition.

The management performed in the Northern area (manure administration, use through mowing and mixed way) favours especially the *Poaceae* and *Fabaceae*. Due to the management, the diversity is larger and also the number of species.

In the Northern area due to the small amount of fertilizer used quite frequently some species more or less oligotrophic persist. This causes an increase in biodiversity in the Northern area.

BIBLIOGRAPHY

Biala, K., M., Zyszkowska, 2004 - *Effects of changes in grassland management on biodiversity and landscape in the Sudeten Mountains in Poland*, Grassland Science in Europe vol. 9 – Land Use Systems in Grassland Dominated Regions, EGF 2004, Luzern, Switzerland, pp. 210-212.

Buzdugan, I., Ciubotariu, C., Popovici, D., Saghin, Gh., 1986 - *Cercetări privind fertilizarea și amendarea pășunilor de Festuca rubra, din etajul subalpin, jud. Suceava*, Lucrări științifice SCPCP Măgurele-Brașov, vol. XI, pp. 79-90.

Marușca, T., Blaj, V., Mocanu, V., Cardașol, V., Georgeta, Oprea, 2010 - *The utilization of improved subalpine pastures by grazing dairy cows*, Romanian Journal of Grassland and Forage Crops, AcademicPress Printers, Cluj Napoca, No. 1/2010, pp. 33.

Michler, B., Reif, A., 2003 - *Arnica montana in the Apuseni Mountains: The case study of Arnica montana L.*, Buletin USAMV-CN, seria Agricultura, 55-56, pp 214.

Michler, B., Rotar, I., Pacurar, F., Stoie, A., 2005 - *Arnica montana L., an endangered species and traditional medicinal plant: the biodiversity and productivity of its typical grasslands habitats*, Grassland Science in Europe, Vol 10, pp 336.

Păcurar, F., Rotar, I., Barbara, Michler, W.W., 2006 - *Manualul folosirii pășunilor cu Arnica montana L.*, Cluj-Napoca (popular pamphlet).

Todorova, P.,D., Pavlov, Petrova, I., 2003 - *Productivity and botanical composition of permanent grassland in the Central Balkan Mountains*, Grassland Science in Europe, vol.8, pg. 64-66 Kathe, W., Honef, S. and Heym, A. 2004. Medicinal and aromatic plants in Albania, Bosnia-Hertegovina, Bulgaria; Croatia and Romania, 91, Bundesamt fur Naturschutz BfN, WWF Deutschland, TRAFFIC Europe-Germany, Bonn und Vilm, pp.201.