

## FLORISTIC COMPOSITION, INTERSPECIFIC RELATIONSHIPS AND PRODUCTIVITY DURING 2006, IN THE MEADOWS WITH *ARNICA MONTANA* FROM GÂRDA DE SUS (APUSENI MOUNTAINS)

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### Abstract

On the limestone plateau of the Garda de Sus commune perimeter the *Arnica montana* habitats were studied during 2006. This area is included in the Apuseni Natural Park. Vegetation samples by metric frame method were taken on random selected areas. Biomass samples were collected over the entire metric frame (1 m<sup>2</sup>) from a height of 5 cm above the ground. We have identified a total of 96 species of vascular plants. For the study of interspecific relationships and productivity the RDA ordination was done. Productivity of green mass had an average value of 6.58 t ha<sup>-1</sup> and the average dry matter productivity was 1.62 t ha<sup>-1</sup>. Both the *Arnica montana* population and his habitats are threatened primarily by changing traditional usage due to their low productivity.

**Keywords:** Mountain grassland, *Arnica montana*, medicinal plant, productivity, Transylvania

### INTRODUCTION

The species *Arnica montana* is found in Romania exclusively in the mountain area and is a valuable medicinal plant, but has also uses in cosmetics. This species is found commonly in grasslands with traditional management on the perimeter of Garda de Sus (Apuseni Mountains) (P curar *et al.* 2006), both on siliceous and calcareous rocks (Stoie *et al.* 2008). In 2006

the *Arnica montana* grasslands on the limestone plateau in the perimeter of Gârda de Sus were studied, this area is also included in the Apuseni Natural Park. These habitats are threatened primarily by changing the mode of use. The current use of these grasslands is mixed, but the main production is the hay used for winter feeding of the local's animals.

Romania is one of the main source countries of dried *Arnica montana* flower heads processed in Central Europe (Kathe *et al.*, 2004). Highly diverse grasslands can still be found in the Apuseni Mountains (Transylvania, Romania), with a total of 143 species identified

(Michler and Reif, 2003). The species rich *Nardus stricta* and *Arnica montana* habitats are listed with the code number - Code 6230 - in the EU-FFH-directive (92/43) and the species *Arnica montana* is listed in Annex V (92/43) (Michler *et al.*, 2005)

## **MATERIAL AND METHOD**

The areas selection where the vegetation samples were taken was performed using a full mapping of the grasslands where medicinal species *Arnica montana* has been identified, on the perimeter of the Gârda de Sus. Random selection was made by the "golden numbers" using the pre-numbered areas in the full mapping. Mapping and selection of sample areas was conducted in the research project "*Arnica montana*". For 2006 in the northern limestone plateau a total of 17 sample areas were randomly selected in the perimeter of Gârda de Sus. On each of these areas one vegetation sample was taken. The plots were established on the full mapping and clearly identified on the ground using satellite images and topographical maps and

confirmed by GPS. The vegetation samples were taken by the metric frame method. All species of vascular plants on the 1 m<sup>2</sup> vegetation sample were identified and their coverage was quantified (in coverage %) with high accuracy especially for species with lower coverage.

The biomass samples were collected from the entire metric frame (1 m<sup>2</sup>) from a height of 5 cm above the ground. Parts from the layer of bryophytes and lichens have not been harvested anyhow they usually do not exceed the height of 5 cm. The green mass was weighed as soon as possible after harvest, taking measures to prevent water loss. The dry matter was obtained by drying at room temperature and then in the oven at a temperature of 100 °C for 3 hours.

To view the interspecific relationships and productivity of dry matter, the data obtained were processed using the program CANOCO for Windows

(version 4.0) by redundancy Analysis (RDA), followed by Monte Carlo permutation test.

## RESULTS AND DISCUSSION

The weighed green mass productivity was between 1.92 t ha<sup>-1</sup> and 10.80 t ha<sup>-1</sup> with an arithmetic mean value of 6.58 t ha<sup>-1</sup> and the weighed dry matter

productivity was between 0.54 t ha<sup>-1</sup> and 2.23 t ha<sup>-1</sup> with an arithmetic mean value of 1.62 t ha<sup>-1</sup>. These values were obtained by reference to the hectare of the weightings performed on the 1 m<sup>2</sup> sample areas. (Fig.1).

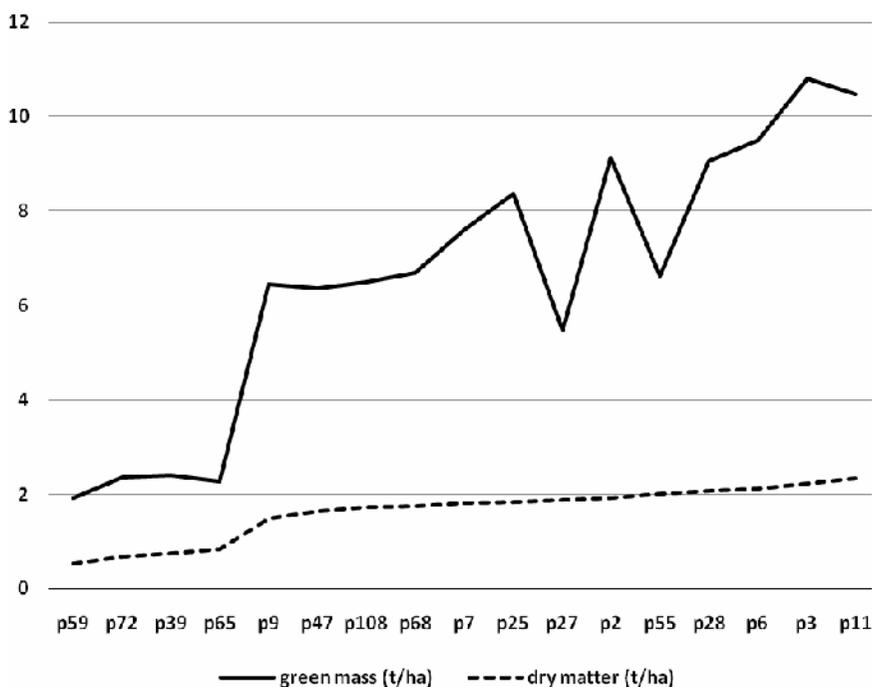


Fig. 1. The productivity of green mass and dry matter in *Arnica montana* habitats during 2006, on the limestone plateau of Gârda de Sus (Apuseni Mountains). (p - parcels numbering with *Arnica montana*)

The vegetation samples taken in the study identified a total of 96 species of vascular plants as follows:

- Species of the family Poaceae: *Agrostis capillaris*, *Anthoxanthum odoratum*, *Briza media*, *Cynosurus cristatus*, *Deschampsia caespitosa*, *Deschampsia flexuosa*, *Festuca rubra*, *Nardus stricta*, *Phleum pratense*, *Trisetum flavescens*.

- Other species of the order Poales (sensu Angiosperm Phylogeny Group 2009): *Carex remota*, *Carex nigra*, *Carex pallescens*, *Carex pilosa*, *Juncus effusus*, *Luzula campestris*.

- Species of the family Fabaceae: *Anthyllis vulneraria*, *Lotus corniculatus*, *Medicago lupulina*, *Trifolium pratense*, *Trifolium repens*.

- Species of other botanical families: *Achillea distans*, *Ajuga genevensis*, *Ajuga reptans*, *Alchemilla vulgaris*, *Anemone nemorosa*, *Antennaria dioica*, *Arnica montana*, *Astrantia major*, *Campanula abietina*, *Campanula patula*, *Campanula serrata*, *Carlina acaulis*, *Carum carvi*, *Centaurea mollis*, *Centaurea pseudophrygia*, *Cerastium holosteoides*, *Cirsium erisithales*, *Clinopodium vulgare*, *Colchicum autumnale*, *Crepis biennis*, *Crocus vernus*, *Dactylorhiza fistulosa*, *Euphorbia carniolica*, *Euphrasia*

*officinalis*, *Galium album*, *Gentianella lutescens*, *Gymnocarpium robertianum*, *Gymnadenia conopsea*, *Hieracium aurantiacum*, *Hieracium bauhini*, *Hieracium murorum*, *Hieracium pilosella*, *Hypericum maculatum*, *Knautia dipsacifolia*, *Lathyrus pratensis*, *Leontodon hispidus*, *Leucanthemum vulgare*, *Pseudorchis albida*, *Lychnis flos-cuculi*, *Linum catharticum*, *Melampyrum sylvaticum*, *Mercurialis perennis*, *Myosotis arvensis*, *Myosotis sylvatica*, *Parnassia palustris*, *Pimpinella major*, *Plantago lanceolata*, *Plantago media*, *Polygala comosa*, *Polygala vulgaris*, *Potentilla erecta*, *Primula elatior*, *Primula veris*, *Prunella vulgaris*, *Ranunculus acris*, *Rhinanthus glaber*, *Rhinanthus minor*, *Rumex acetosa*, *Scabiosa columbaria*, *Scorzonera rosea*, *Silene nutans*, *Soldanella hungarica*, *Solidago virgaurea*, *Stachys alpina*, *Stellaria graminea*, *Taraxacum officinale*, *Thymus pulegioides*, *Trollius europaeus*, *Vaccinium myrtillus*, *Veratrum album*, *Verbascum nigrum*, *Veronica chamaedrys*, *Veronica officinalis*, *Viola canina*, *Viola declinata*.

After the RDA analyzes the amount of dry matter explained 13% of the total variance of the floristic composition ( $p = 0.03$ ). Species that occur only in one or

two vegetation samples were excluded to avoid distorting the results of ordination.

From the family *Poaceae* the species *Festuca rubra*, *Agrostis capillaris*, *Anthoxanthum odoratum*, and to a lesser extent *Cynosurus cristatus* are relatively common and important in terms of feed. These species can be observed in the left RDA ordination contributing not only to productivity increases but also to higher quality of the hay (Fig. 2). The important forage species *Trisetum flavescens* had a high dominance in eutrophic meadows with higher productivity for the studied area and is rare and shows low coverage in the habitats of the species *Arnica montana*. *Nardus stricta* and *Deschampsia flexuosa* can be identified to the right of the RDA ordination, characterizing grasslands with relatively low productivity.

The other species of the order *Poales* (*sl.*) have generally low coverage and are represented in the right side of the ordination by the genus *Carex* and in the left *bauhini*, *Hieracium murorum* and *Vaccinium myrtillus*. This group of oligotrophic species generally characterizes lower productivity in the examined grasslands. The

side of the ordination by *Luzula campestris*, but both genera generally occur in grasslands with lower productivity. (Fig.2)

The species belonging to the family *Fabaceae*, represented especially by *Trifolium pratense*, *Trifolium repens*, *Lotus corniculatus* and *Anthyllis vulneraria* are in the left part of the RDA ordination, contributing to a large extent to increased productivity and hay quality. (Fig.2)

Among the species from the other botanical families a great importance has the species *Arnica montana*, its habitats representing the theme of this study. *Arnica montana* although it occurs in all habitats examined, it has a greater preference for those dominated by *Nardus stricta* or *Deschampsia flexuosa*. In this group from the right side of the RDA ordination are represented also some oligotrophic species such as *Potentilla erecta*, *Hieracium pilosella*, *Hieracium*

common bilberry (*Vaccinium myrtillus*) although it may produce some increases in productivity, being a chamaephyte, its lignified

branches had no forage value. (Fig.2)

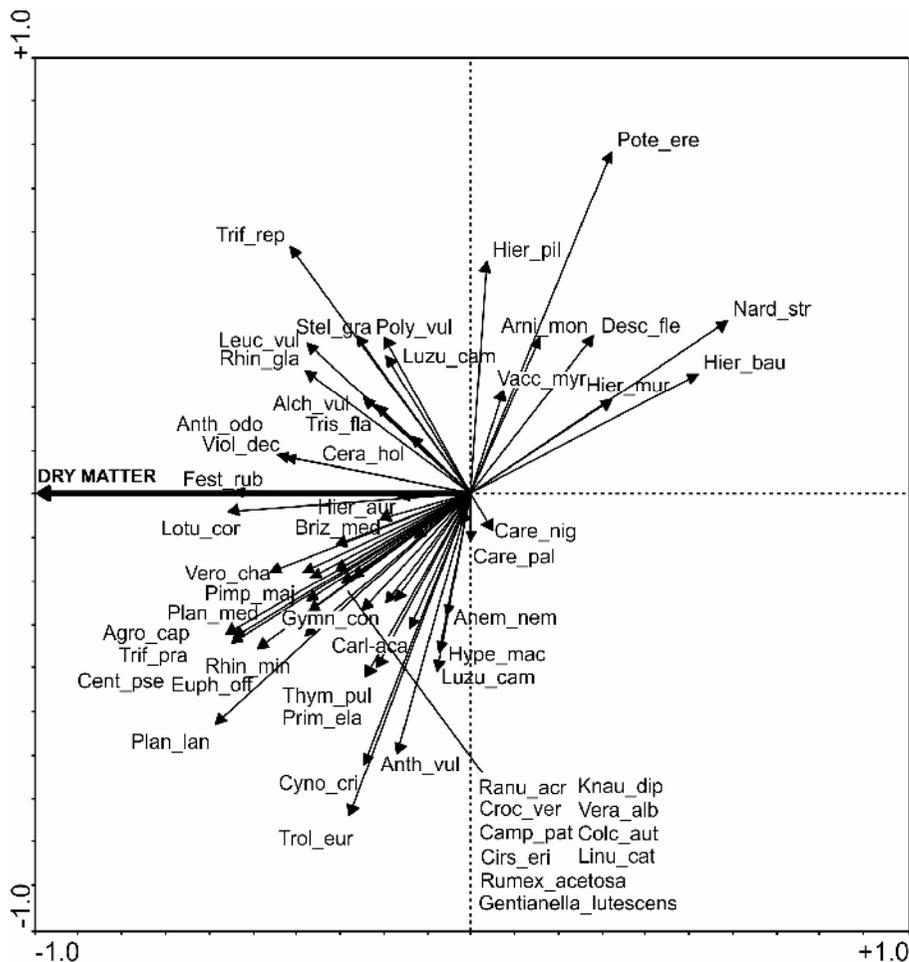


Fig. 2. Ordination diagram of species and dry matter yield from *Arnica montana* habitats in the floristic space defined by RDA, based on species cover values. (The first four letters are the abbreviation of the genus and the last three are the species abbreviation)

Most of the species from the other botanical families are found in the left side of the RDA ordination, characterizing relatively higher productivities. Here is also *Gymnadenia conopsea* which is the most common species of the *Orchidaceae* family in the analysed grasslands. The species of this botanical family have a high protective value at European level. (Fig.2)

Hemiparasitic species from the family *Orobanchaceae* (*sensu* Angiosperms Phylogeny Group 2009), represented by *Rhinanthus glaber*, *Rhinanthus minor*, *Euphrasia officinalis* are also common in the analysed samples and can be identified to the left of the RDA ordination. (Fig.2)

Although the main harvest in the analyzed grasslands was the hay mown only once per year, most of them were used mixed, being grazed in spring and autumn. Due to their low productivity in the current European Union context, the maintaining of the profitability and the floristic composition, with the interspecific relationships presented in this study remains

with uncertain future (Stoie *et al.* 2009). A phenomenon commonly observed in mountain meadows in Romania is the abandon of use, followed by the succession to shrub and forest woody vegetation. This trend can be seen often in the grasslands of the study area. These major successions determine rapid floristic composition changes (Alibegovic-Grbic *et al.* 2002). Another possibility is the transformation of the meadows to extensive or intensive pastures, in order to decrease the workload. This transformation usually causes significant changes in floristic composition and interspecific relationships, depending on grazing animals and to the way in which the grazing is conducted (Ludvikova *et al.* 2009, Seither *et al.* 2010). An effective practice to increase productivity is intensification or fertilizing (Vintu *et al.* 2009). These practices cause significant reductions in the floristic composition and diversity of mountain meadows (P curar *et al.* 2004, Rotar *et al.* 2010, Stybnarova *et al.* 2009). However for this purpose are

preferred areas with more favorable soil conditions than those of the *Arnica*

*montana* grasslands, which usually have less fertile soils.

## **CONCLUSIONS**

In the absence of effective measures for the conservation of the habitats considered in this study, accelerated change in the traditional way of use will continue in the future. Depending on the intensity of the changes in the mode of use imposed by low productivity, the population of the *Arnica montana* medicinal species may be strongly endangered. Also it may be endangered the abundance of other species in its habitats and the dynamic equilibrium of the complex interspecific relationships between them. Some of these species also have a high protective value, such as for example species of the family *Orchidaceae*. It may be endangered the whole complex of species identified in the *Arnica montana* habitats that forms a colorful grass carpet for long periods of the year and contribute significantly to the composition of the characteristic landscape of the studied area, area included in the Apuseni Natural Park.

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