VASCULAR PLANT SPECIES RELATIONSHIP AND GRASSLAND PRODUCTIVITY IN ARNICA MONTANA HABITATS IN THE LIMESTONE AREA OF GÂRDA DE SUS VILLAGE (APUSENI MOUNTAINS – ROMANIA)

RELAŢIILE INTERSPECIFICE ALE PLANTELOR VASCULARE ŞI PRODUCTIVITATEA PAJIŞTILOR ÎN HABITATELE CU ARNICA MONTANA DIN REGIUNEA CALCAROASĂ A COMUNEI GÂRDA DE SUS (MUNŢII APUSENI– ROMÂNIA)

Stoie Andrei, Rotar Ioan

University of Agricultural Sciences and Veterinary Medicine, Faculty of Agriculture, 3-5, Manastur street, 400372, Cluj-Napoca, Romania, andreisbio@yahoo.de, rotarioan52@yahoo.com

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ABSTRACT

The Apuseni Mountains region (Romania) holds one of the most important romanian grassland areas with the medicinal species protected over Europe – Arnica montana. Following several studies on vegetation growing in the limestone region of Gârda de Sus village, one can conclude that there are some correlations between the species present in the Arnica montana habitats and also between those and the grasslands productivity. The coverage degree of every species was quantified by metric frame method. Arnica montana shows a weak positive correlation with the strong oligotrophic species within the studied grasslands. The habitats productivity show variable correlations with the vascular plants within the Arnica montana habitats. The Arnica montana presents no preferences for the productivity level of the grasslands where it grows, but only within a very restricted range of low productivity that characterize this grasslands.

Key words: mountain grasslands, Arnica montana, medicinal plant, productivity, Transylvania

REZUMAT

Regiunea Munților Apuseni (România) găzduieşte una dintre cele mai importante suprafețe de pajişti cu specia medicinală protejată în Europa – Arnica montana. În urma studiilor de vegetație efectuate în regiunea calcaroasă a comunei Gârda de Sus au putut fi puse în evidență unele corelații care există între speciile prezente în habitatele cu Arnica montana precum şi între acestea şi productivitatea pajiştilor. Gradul de acoperire al fiecărei specii a fost cuantificat prin metoda ramei metrice. Arnica montana prezintă o slabă corelație pozitivă cu speciile puternic oligotrofe din cadrul pajiştilor studiate. Productivitatea habitatelor prezintă corelații variabile cu plantele vasculare din cadrul habitatelor cu Arnica montana. Nu se evidențiază preferința speciei Arnica montana pentru un anumit nivel al productivității pajiştilor în care este răspândită, însă doar în cadrul unui interval strict de productivitate scăzută care caracterizează aceste pajişti.

Cuvinte cheie: pajişti montane, Arnica montana, plante medicinale, productivitate, Transilvania.

REZUMAT DETALIAT

Regiunea Munților Apuseni găzduieşte una dintre cele mai importante suprafețe de pajişti cu Arnica montana din România, reprezentând în acelaşi timp în Europa şi una dintre cele mai importante surse pentru antodii uscate de arnica [6]. Habitatele cu Arnica montana din regiunea studiată sunt reprezentate de pajişti secundare, oligotrofe care sunt întreținute continuu printr-un management tradițional, fiind utilizate aproape exclusiv ca şi fânețe. În cadrul studiului de față s-au ridicat relevee de vegetație prin metoda ramei metrice, cuantificând gradul de acoperire al fiecărei specii cu o aproximație de până la 0,25%, mai ales pentru speciile cu un grad de acoperire redus. Pentru studiul productivității s-a recoltat, de pe întreaga suprafață a ramei metrice ($1m^2$), întreaga cantitate de fitomasă de la o înălțime de 50 mm deasupra solului. Cele 103 specii de plante vasculare identificate au fost studiate din punctul de vedere al relațiilor interspecifice precum şi al corelațiilor cu productivitatea, utilizând unele programe specializate cum ar fi SPSS şi CANOCO. S-a constatat astfel că habitatele cu Arnica montana sunt strict limitate pe suprafețe cu o productivitate relativ scăzută (0.98 – 2.38 t/ha substanță uscată) (fig. 2). Compoziția floristică şi acoperirea speciilor identificate denotă o valoare furajeră de asemenea scăzută a acestor pajişti. Specia studiată nu arată însă o preferință pentru pajiştile cu o productivitate extrem de scăzută în cadrul intervalului de productivitate scăzută mai sus amintit. Preferința de asociere cu specii extrem oligotrofe este foarte slab pusă în evidență de diagrama de ordonare a speciilor (fig.1). În concluzie o creştere pronunțată a productivității mai ales prin fertilizare ar avea un impact negativ rapid asupra populațiilor de Arnica montana putând duce la dispariția lor totală. Pe de altă parte menținerea productivității scăzute precum şi a compoziției floristice care reflectă o valoare furajeră scăzută vor fi dificile datorită nerentabilității întreținerii acestora. Includerea acestor habitate cu Arnica montana în cadrul parcului natural Apuseni măresc şansele menținerii lor, deşi resursele financiare lipsesc în momentul de față. Recoltarea şi comercializarea antodiilor de arnica poate duce la ameliorarea rentabilității acestor pajişti şi deci cresc şansele menținere lor, atâta timp cât aceste recoltări nu pericliteză stabilitatea populațiilor de Arnica montana însăşi.

INTRODUCTION

The Apuseni Mountains region (Romania) holds one of the most important grassland areas with Arnica montana, a medicinal plant protected in Europe. Romania is also one of the most important sources of dry anthodia of Arnica montana within Central Europe [6]. The Arnica montana habitats are secondary, oligotrophic grasslands which need continuous traditional use through grazing or – almost exclusively in the studied area - through mowing. The harvest is relatively low, which leads to low economical profitableness and fragile sustainability in maintain these grasslands. The Arnica montana habitats within the studied area show in general a large floristic diversity. The preferences of plant species for Arnica montana habitats are expected to be largely variable. Following several studies on vegetation growing in the limestone region of Gârda de Sus village (in the Apuseni Mountains), we aimed to test the correlations between the abundance of plant species present in the Arnica montana habitats, and their relationships with grassland productivity.

MATERIAL AND METHOD

During the year 2005 a series of 26 vegetation plots were sampled in the Arnica montana habitats within the northern area of Gârda de Sus village (in Apuseni Mountains). The sampling quadrates were randomly selected from all Arnica montana plots previously mapped in the whole studied area [5]. The cover off all vascular plant species was percentual quantified by metric frame method (1 m^2 plot) with 0,25% cover accuracy, especially accurate for the species with low cover.

The above ground phytomass of all vascular plant species was harvested from 50 mm above the ground on each 1 m^2 plot. The green phytomass was weighted right after harvesting, the hay yield after drying it at 20ºC and finally the dry matter after 3 hours drying in the oven at 100ºC.

The data were analyzed with SPSS and CANOCO software. The species that appear in just two samples, respectively in just one, were eliminated from the ordination diagrams, to not disturb the graduation results.

The ordination diagrams of species, obtained with the CANOCO software [10], show the two axes, those for DCA (Detrended Correspondence Analysis) unimodal indirect graduations and RDA (Redundancy Analysis) linear direct graduation respectively. The axes length is expressed in standard deviation units (SD). According to the DCA outcome (table 1), the dominant response of species is mostly linear, and consequently the RDA was used subsequently. The data used in these analyses were the accurate cover percentage values of the vascular plant species in the studied sample areas.

Table 1. Output summary of DCA applied on species
Tabel 1. Sumarul analizei DCA pentru specii.

Axes	1	2	3	4	Total inertia
Eigenvalues:	.332	.233	.171	.093	2.431
Lengths of gradient :	2.928	2.243	2.148	2.005	
Cumulative percentage variance of species data:	13.7	23.2	30.3	34.1	
Sum of all unconstrained eigenvalues					2.431

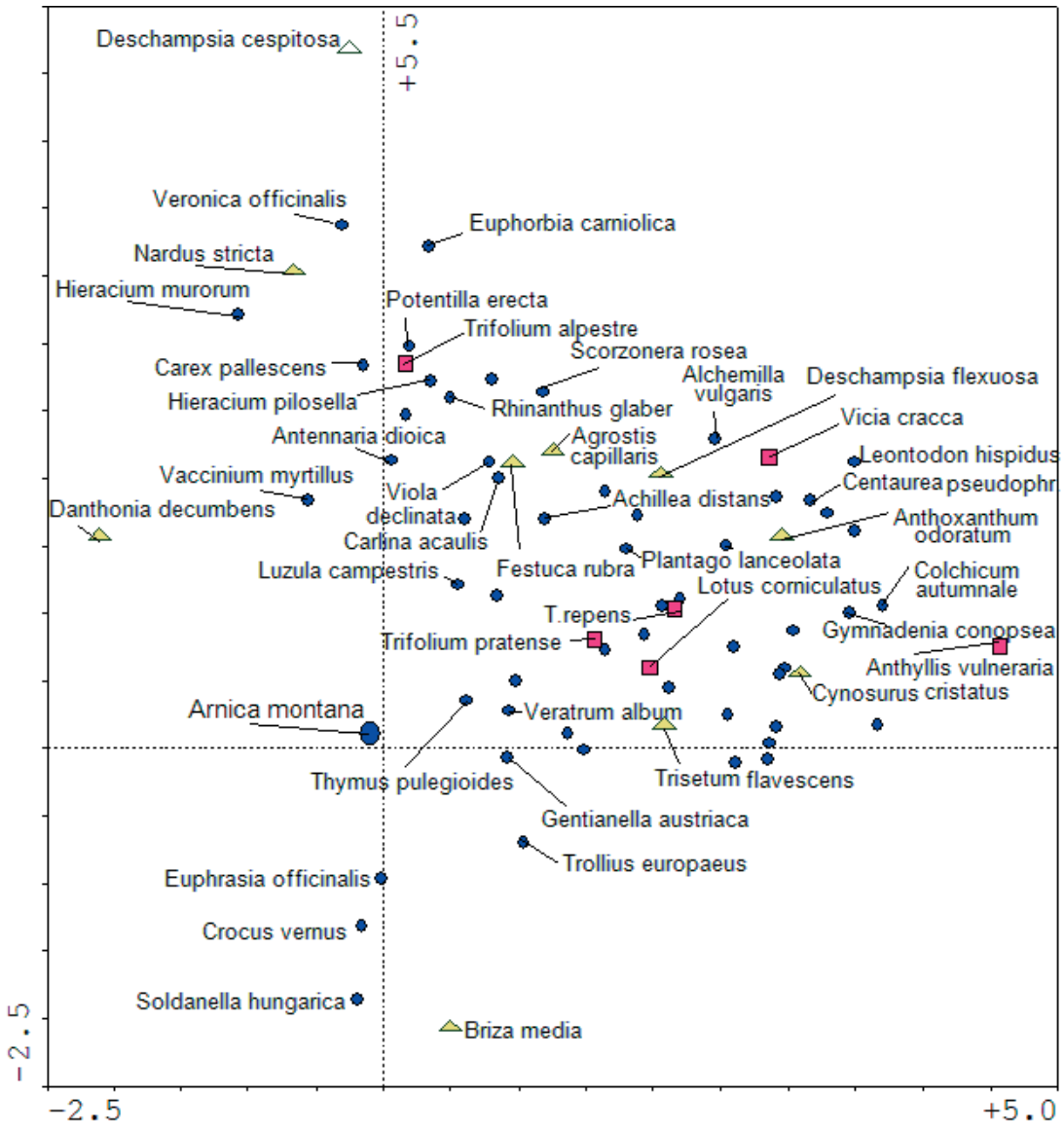

Figure 1. Species ordination diagram in Arnica montana habitats along the first two DCA axes, based on species cover values (Δ- Poaceae, ■- Fabaceae, ◦ - other families)

Figura 1. Diagrama de ordonare a speciilor de-a lungul primelor două axe DCA, pe baza valorilor de acoperire a speciilor. (Δ- Poaceae, ■- Fabaceae, ◦ - alte familii)

RESULTS AND DISCUSSIONS

103 species of vascular plants were identified in the 26 samples. An ordination of species from the Arnica montana habitats in the space formed by the first two DCA axes (Figure 1) shows a conspicuous cluster in the upper right area, for most of the core species within the Arnica montana habitats. Arnica montana is situated somewhere in the middle of the ordination space, showing a relatively low correlation with the core group of species within its habitat.

The correlation vector direction shows a slight negative correlation with the core species of the habitat, namely species that prefer mesotrophic (i.e. Festuca rubra, Agrostis capillaris, Plantago lanceolata etc.) or even eutrophic (i.e. Trisetum flavescens, Trifolium pratense, Trifolium repens etc.) habitats in the studied area. A slight positive correlation with the oligotrophic and acidophilic species situated in the upper left side of the correlation diagram (i.e. Danthonia decumbens, Nardus stricta, Vaccinium myrtillus, Veronica officinalis etc.) can be also observed. The opposite side of the diagram, namely lower right side, is populated by a small number of species displaying a negative Arnica montana correlation, of which Trollius europaeus is worthy to be mentioned.

One can observe also a lack of positive correlation of Arnica montana with poaceous and fabaceous species, which are important as fodder. Thus, the hay yielded on the Arnica montana grasslands will show lower fodder value.

After the vegetation samples were weighted, the data show an average of 7.85 t/ha for green mass, 2.26 t/ha for hay and 1.97 t/ha for dry matter. These values indicate a relatively low productivity for the habitats situated in the studied area (Păcurar et al. 2004). According to literature, with fertilizer treatments, the grasslands productivity in these areas can surpass 5-6 t/ha dry matter. The grasslands that showed already increased productivity were excluded from this study, because Arnica montana doesn't occur in thus fertile habitats. The productivity of these grasslands is strongly related to soil fertility (Păcurar et al. 2004).

The hay and dry matter box plots in Figure 2 indicate

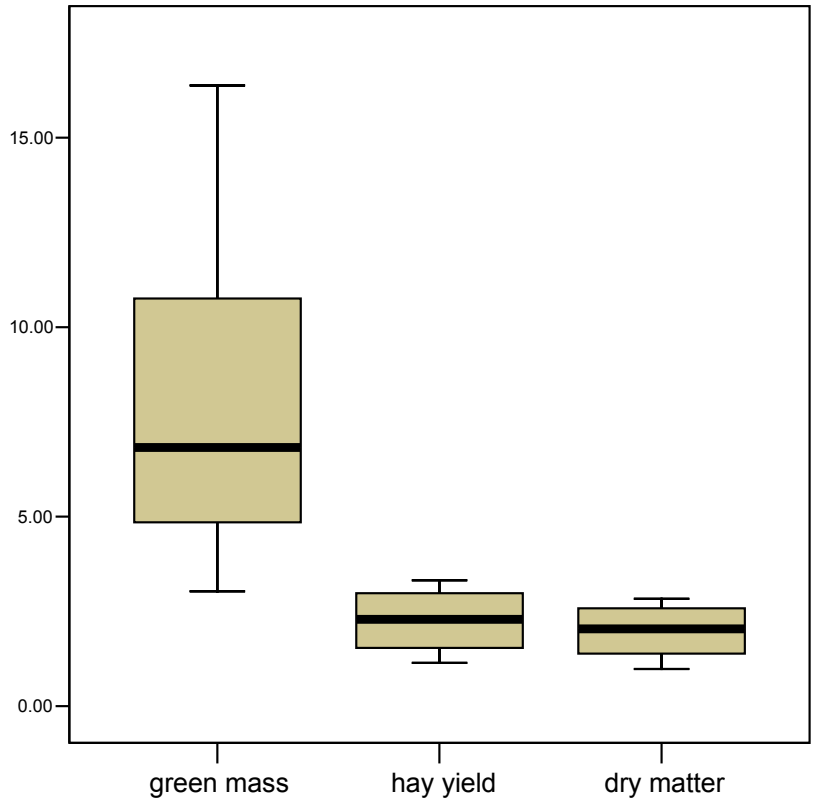

Figure 2. Green phytomass (t/ha), hay yield (t/ha) and dry matter (t/ha) values for the Arnica montana grasslands from the northern (limestone) area of Gârda de sus village (Apuseni Mountains)

Figura 2. Fitomasa verde (t/ha), producția de fân (t/ha) și substanța uscată (t/ha) pentru pajiștile cu Arnica montana din regiunea nordică (calcaroasă) a comunei Gârda de sus (Munții Apuseni)

a very strict limitation of Arnica montana habitats spreading over grasslands with low levels of productivity and obviously with low degree of eutrophicity. This productivity ranges between 0.98 and 2.38 t/ha of dry matter. Based on the hay yield and dry matter data for this variation, one can conclude that there are no indications showing the preferences of the habitats towards high productive grasslands (and higher eutrophicity degree), or small productive grasslands (and strongly oligotrophic).

By graduating the species from Arnica montana habitats in correlation to dry matter yield, in the space limited by the first two RDA axes, it cannot be observed a obvious grouping of species in a certain area of graduation diagram (Figure 3). Still, it can be observed a slightly general preference of a large number of species for grasslands with increased productivity, as shown in the left side of the diagram.

The most numerous group of species is in the lower left side of the graduation diagram, correlated with the dry matter. Here are grouped the species that showed positive correlations with a higher productivity of the grasslands (i.e. Agrostis capillaris, Trisetum flavescens, Anthoxanthum odoratum, Deschampsia cespitosa, Deschampsia flexuosa, Gymnadenia conopsea, Centaurea pseudophrygia, Plantago media, etc). The species Festuca rubra, Trifolium pratense and Trifolium repens, important for forage, are located near the mentioned cluster and are also positive correlated with productivity.

The group with the highest number of species negatively correlated with productivity (i.e. Danthonia decumbens, Nardus stricta, Vaccinium myrtillus, Potentilla erecta, Thymus pulegioides, etc) is located oppositely i.e. in the upper right side of the diagram.

The position of Arnica montana near the upper end of the second axis confirms the lack of correlation with its habitat productivity (Michler et al. 2005). The correlation vector angle, smaller than 90°, pointing to the left side, suggests a very light tendency towards grasslands with

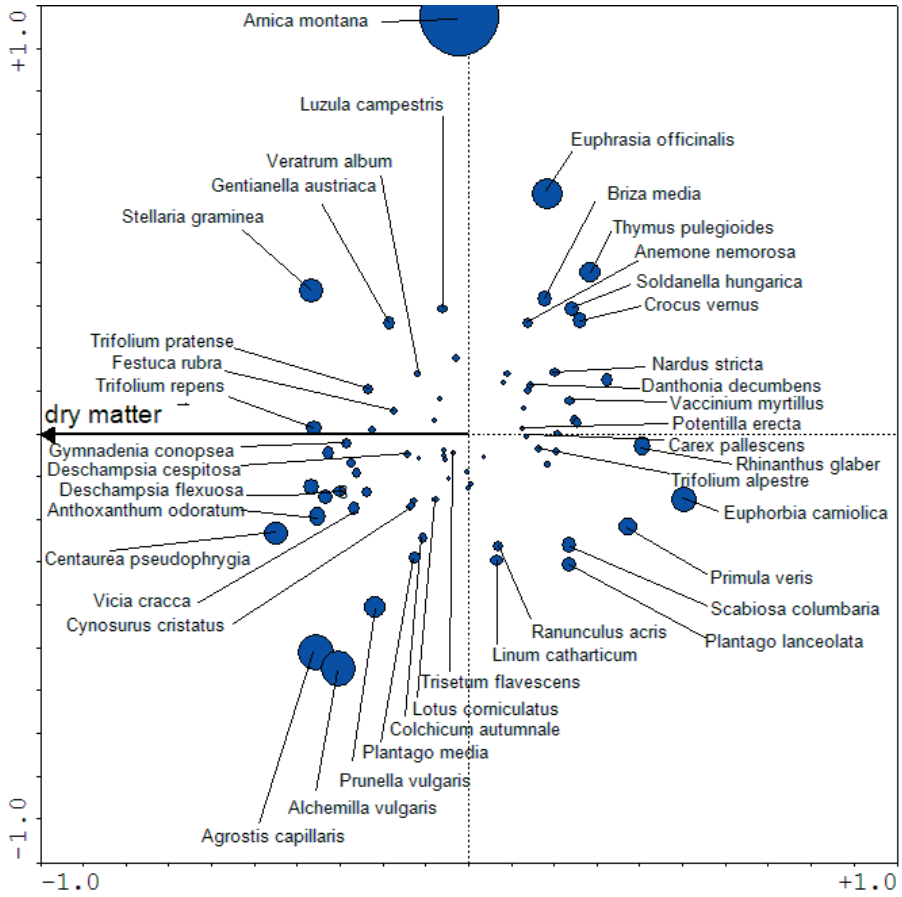

Figure 3. Ordination diagram of species and dry matter yield from Arnica montana habitats in the floristic space defined by the first two RDA axes, based on species cover values.

Figura 3. Diagrama de ordonare a speciilor şi a producţiei de substanţă uscată din habitatele cu Arnica montana, în spaţiul definit de primele două axe RDA, pe baza valorilor de acoperire a speciilor.

slightly enhanced productivity.

Among the species strongly correlated with Arnica montana concerning the productivity, in the graduation diagram are especially noted Euphrasia officinalis and Luzula campestris species. Also Anemone nemorosa, Crocus vernus, Soldanella hungarica species showed a correlation with Arnica montana. The latter which are specific to forest and fringe vegetation, confirms out on-site observations, namely that numerous Arnica montana habitats can be found near forest edges, or on grasslands formed after relatively recent small area deforestation.

CONCLUSIONS

A narrow variation in productivity of grasslands with Arnica montana (0.98 – 2.38 t/ha dry matter) has been ascertained. Increasing the productivity through massive fertilizations leads probably to a very quick disappearance of Arnica montana, along with other associated species. On the other hand, an excessive low productivity and oligotrophicity might also have negative impact on Arnica montana population. The low correlation between Arnica montana and the main fodder plants of the studied area represents an additional danger for the profitableness and sustainability of these habitats. By including the studied area in the Apuseni Natural Park, the hope for maintaining these grasslands has increased, though the financial resources are lacking at the moment. The low income obtained from these grasslands can be supplemented through harvesting and marketing the Arnica montana anthodia. This can favor the conservation and sustainability of these habitats as long as the harvesting doesn't endanger the stability of the Arnica montana populations itself.

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