VEGETATION OF THE BOREAL AND SUBALPINE MEADOWS OF THE VLĂDEASA MOUNTAINS, WESTERN CARPATHIANS

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RESEARCH ARTICLE

Abstract

The main goal and objectives of the paper consist in conducting the floristic, phytosociological, ecological survey of the vegetation built up by the phytocoenosis species of the Phleo alpini-Deschampsietum caespitosae association. In order to achieve the goal put forward, we set several objectives targeting the floristic composition and the ecological analysis of the bioforms and phytogeographical elements, and the ecological indices of the species found in the surveyed territory and included in the synthetic association table. The results of the work emphasize the floristic composition and the biodiversity of the phytocoenosis, as well as the analysis of each individual species from the perspective of bioform, geographical element and ecological indices highlighted in the table and histograms on the numerical weight of the species.

Keywords: Subalpine meadows, geoelements, coenotaxa, *Phleum alpinum*, biodiversity
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INTRODUCTION

The boreal and subalpine meadows of the Vlădeasa Mountains, built up by *Phleum alpinum* and *Deschampsia caespitosa*, tend to expand due to a faulty exploitation of the meadows (Chifu et al. 2006). These phytocoenoses are frequently spread in the boreal and subalpine floors of the Romanian Carpathians, settling on flat lands or on land with gentle to moderate slopes (2-12°), in humid micro-depressions, on podzolic or oligo-mesobasic soils, rich in humus, at altitudes above 1,300 m (Chifu et al. 2014).

The purpose of this research is to prepare a floristic, phytosociological and ecological study of the vegetation built by the taxa of phytocenosis ***Phleo alpini - Deschampsietum caespitosae*** (Morariu 1939) Coldea 1983, aiming at reaching the following objectives:

- Making of floristic inventory of the species within this association;
- Running the analysis of the living soil cover and the classification of the phytotaxa according to their affinity to the coenotaxa, alliance, order, vegetation class;
- Carrying out the ecological analysis of the species found in the surveyed territory in terms of bioforms, chorological and ecological categories.

MATERIAL AND METHOD

The biological material subjected to research consists of the phytocoenoses of the association ***Phleo alpini - Deschampsietum caespitosae*** spread in the boreal and subalpine floors of the Vlădeasa Mountains respectively in Poiana Stânișoara (at 1,676m), Gruieșu (at 1,683, 1,679, 1,670m), Briței Mountain (at 1,694m), Gruiu Ursului (at 1,425, 1,418m), Baia Popi (1,389m). The sampling areas surveyed (50-200m^2) are located on land with a gentle to moderate slopes (2-12°), on flat land, with Northern, Western, Southern exposure, confirming the increased demand for light and soil moisture, on podzolic soils, humid districambosoils, hydric humid marshy soils, rich in humus with high fertility, and partially grazed.

For the identification of the taxa that form the living soil cover of this phytocenosis, we made use of the methods developed by Braun-Blanquet (1964) which were tailored to the characteristics of the vegetation of meadows by Borza et Boșcaiu (1965), Ivan et Doniță (1975), Ivan et Spiridon (1983), Ivan (1992).

We analysed the ***Phleo alpini - Deschampsietum caepitosae*** community as a taxonomic unit according to Géhu et Rivas-Martinez (1981).

The 8 sample areas were selected as the most representative areas in the Vlădeasa Mountains and were included in the synthetic table of association with the species ordered by

Figure 1 ***Phleo alpini-Deschampsietum caespitosae*** **association (original picture, Poiana Stânișoara, 18.07.2023)**

coenotaxa, alliance, order, class, with the assessment of abundance-dominance indices (ADm) and constancy classes (K=I-V) according to the system Braun-Blanquet et Pavillard (1928), Braun-Blanquet (1964), Tüxen (1955) , Soó (1964-1980), Borza et Boşcaiu (1965), Oberdorfer (1992), Pott (1995), Mucina (1997), Borhidi (1996), Rodwell et al. (2002), Sanda et al. (2008), Coldea et al. (2012), Chifu et al. (2014).

We carried out the classification of cormoflora by ecological categories of bioforms by reviewing the works elaborated by Raunkier (1937), Braun-Blanquet (1964), Sanda et al. (2003), Burescu et Toma (2005), Ciocârlan (2009).

We determined the florigenetic origin of the phytotaxa according to Meusel et Jäger, Sanda et al. (2003), Coldea et al. (2006)

We made the classification of species by the ecological categories in terms of soil moisture, air temperature and chemical reaction of soil according to the works of the authors Ellenberg (1979), Sanda et al. (2008).

We processed the results of the work on phytocenosis biodiversity using tables, histograms and diagrams.

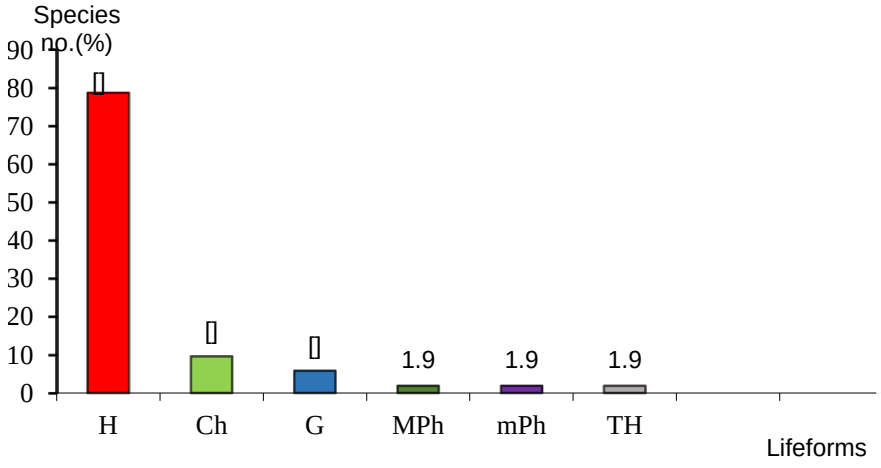

Figure 2. **Spectrum of lifeforms from the *Phleo alpini-Deschampsietum caespitosae* association**

RESULTS AND DISCUSSIONS

The floristic composition of the ***Phleo alpini – Deschampsietum caespitosae phytocenosis*** (see Figure 1) highlights the coenotic biodiversity, totaling 52 cormophytes in which the characteristic species that builds the association i.e. *Deschampsia caespitosa* has ADm=63.12% and the maximum constancy K=V while *Phleum alpinum* has ADm=12.18, K=V, being in a codominance relationship. Two species from the ***Calamagrostion villosae*** alliance grow here (*Campanula abietina*, *Hypericum richeri* ssp. *grisebachii*), while from the order and class ***Adenostyletalia alliariae*** and ***Betulo-Adenostyletea*** (see Table 1) there are present seven species *(*i.e. *Rumex alpinus*, *Hypericum maculatum*, *Senecio subalpinus*, *Chaerophyllum hirsutum*, *Crepis paludosa*, *Myosotis sylvatica*, *Stellaria nemorum*). Alongside these species, the association also includes transgressive species from the ***Molinio-Arrhenatheretea*** class - 13 species (i.e. *Leontodon hispidus*, *Stellaria graminea*, *Anthoxantum odoratum*, *Juncus effusus*, *Rumex acetosa*, *Trifolium repens* ssp. *alpinum*, *Trifolium repens* ssp. *repens*, *Carum carvi*, *Caltha palustris* ssp. *laeta*, *Cerastium holeosteoides*, *Dactylorhiza maculata* ssp*. maculata*, *Myosotis scorpioides*, *Prunella vulgaris*), ***Nardo-Callunetea*** class - 13 species (e.g. *Festuca rubra* ssp. *nigriscens*, *Hieracium aurantiacum*, *Potentilla ternata*, *Luzula sudetica*, *Viola declinata*, *Nardus stricta*, *Agrostis capillaris*, etc…), ***Vaccinio-Piceetea*** class **-** 6 species (e.g. *Picea abies*, *Juniperus sibirica*, *Soldanella montana*) while other nine accompanying species are found in the Vlădeasa Mountains (see Table 1).

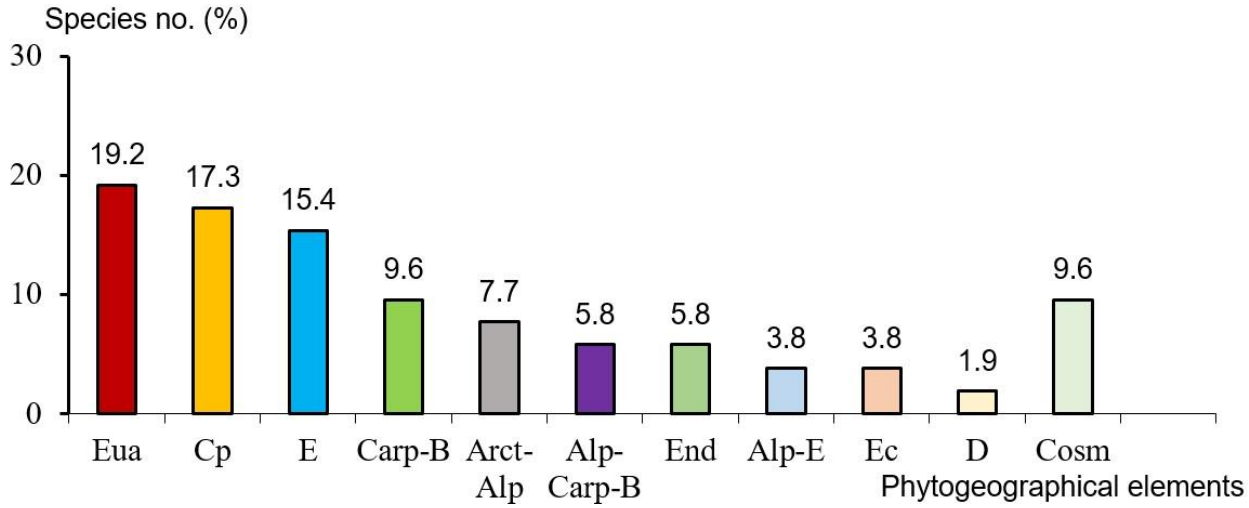

Figure 3. **Spectrum of phytogeographical elements from *Phleo alpini-Deschampsietum caespitosae* association**

The spectrum of bioforms highlights the high share of hemicryptophytes (78.8%) followed by camaephytes (9.6%), geophytes (5.8%) while annual therophytes, megaphanerophytes and mesophanerophytes have an insignificant presence of 1.9% (see Figure 2).

In the participation of floristic elements in the composition of geoelements spectrum, we note the dominance of the following species: Eurasian (19.2%), circumpolar (17.3%), European (15.4%), Carpatho-Balkan (9.6%), cosmopolitan (9.6 %), arctic-alpine (7.7%), alpine-Carpatho-Balkan at parity with the endemic species -5.8%. Alpine-European and Central European elements represent 3.8% and Dacian elements have a share of 1.9% (see Figure 3).

Table 1

Plant associaton *Phleo alpini-Deschampsietum caespitosae* (Morariu 1939) Coldea 1983

Bio	P.e	M	T	R	Survey no.	1	2	3	4	5	6	7	8	K	ADm
					Altitude (mamsl)	1676	1683	1679	1670	1694	1425	1418	1389		
					Grassy layer coverage (%)	90	70	90	100	80	70	90	100		
					Exposure	N	V	V	-	S	-	-	N		
					Slope(°)	2-8	6-12	2-4	-	4-8	-	-	4-6		
					Surface (m^2)	200	200	200	200	200	50	200	150		
					As. *Deschampsia*										
H	Cosm	4	0	0	*caespitosa*	4	2	4	4	4	4	5	5	V	63.12
H	Arct-Alp	3	2	0	As. *Phleum alpinum*	2	3	1	2	1	1	1	1	V	12.18
					Calamagrostion villosae										
H	Carp-B	3.5	2	2	*Campanula abietina*	+	.	+	+	+	+	+	+	V	0.43
H	Alp-Carp-B	2.5	2.5	3	*Hypericum richeri ssp. grisebachii*	.	.	+	.	+	.	.	.	II	0.12
					Adenostyletalia alliariae et Betulo-Adenostyletea										
H	Alp-E	3.5	2	0	*Rumex alpinus*	.	.	.	1	.	+	+	.	II	0.75
H	Eua	4	3	3	*Hypericum maculatum*	.	.	.	.	.	+	+	+	II	0.18
H	Alp-Carp-B	3.5	2	3	*Senecio subalpinus*	.	+	+	.	.	.	.	.	II	0.12
H	Ec	4.5	2	0	*Chaerophyllum hirsutum*	.	.	+	.	.	.	.	.	I	0.06
H	E	3.5	1.5	3	*Crepis paludosa*	+	.	.	.	.	.	.	.	I	0.06
H	E	3.5	3	3	*Myosotis sylvatica*	.	+	.	.	.	.	.	.	I	0.06
H	E	3.5	3	3	*Stellaria nemorum*	.	.	.	.	.	.	+	.	I	0.06
					Molinio-Arrhenatheretea										
H	Eua	2.5	0	0	*Leontodon hispidus*	+	+	+	+	.	.	.	.	III	0.25
H	Eua	2.5	2	3	*Stellaria graminea*	.	+	+	.	.	+	.	+	III	0.25
H	Eua	0	0	0	*Anthoxanthum odoratum*	+	.	.	.	+	.	.	.	II	0.12
H	Cosm	4.5	3	3	*Juncus effusus*	.	.	.	.	.	+	+	.	II	0.12
H	Cosm	3	0	0	*Rumex acetosa*	.	.	.	.	.	+	+	.	II	0.12
H	Alp-E	3.5	0	0	*Trifolium repens ssp. alpinum*	.	+	+	.	.	.	.	.	II	0.12
H	Eua	3.5	0	0	*Trifolium repens ssp. repens*	.	+	.	+	.	.	.	.	II	0.12
TH	Eua	3.5	3	3	*Carum carvi*	+	.	.	.	.	.	.	.	I	0.06
H	Cp	5	2	0	*Caltha palustris ssp.laeta*	.	.	.	.	+	.	.	.	I	0.06
Ch(H)	Cosm	3	0	0	*Cerastium holeosteoides*	.	.	+	.	.	.	.	.	I	0.06
G	E	4	2	2	*Dactylorhiza maculata ssp. maculata*	.	.	.	.	+	.	.	.	I	0.06
H(Hh)	Eua	5	3	0	*Myosotis scorpioides*	.	.	.	.	+	.	.	.	I	0.06
H	Cosm	3	3	0	*Prunella vulgaris*	.	+	.	.	.	.	.	.	I	0.06
					Nardo-Callunetea										
H	Cp	3	0	0	*Festuca rubra ssp. nigriscens*	+	1	1	+	1	+	+	+	V	2.18
H	Arct-Alp	3.5	2	4	*Hieracium aurantiacum*	.	+	+	+	+	.	.	+	IV	0.31
H	Eua	0	2	2	*Luzula sudetica*	+	+	.	+	+	+	.	.	IV	0.31
H	Carp-B	3.5	2	2	*Viola declinata*	.	+	+	+	.	+	.	+	IV	0.31
H	Carp-B	0	1.5	2	*Potentilla ternata*	+	+	+	.	+	.	.	.	III	0.25
H	E	3	2	0	*Alchemilla vulgaris*	.	+	+	1	.	.	.	.	II	0.75
H	Cp	0	0	0	*Agrostis capillaris*	.	.	.	.	.	+	+	+	II	0.18
H	Cp	4	2.5	3	*Carex leporina*	.	.	+	+	.	.	.	.	II	0.12
H	E	0	0	5	*Nardus stricta*	.	.	.	.	+	+	.	.	II	0.12
H	Eua	4	1	0	*Potentilla erecta*	.	.	.	+	.	+	.	+	II	0.18
G	E	3	2	2	*Pseudorchis albida*	+	.	.	.	+	.	.	.	II	0.12
Ch	Eua	2	2	2	*Veronica officinalis*	.	.	.	.	.	+	+	+	II	0.18
H	Cp	2.5	3	0	*Hieracium umbellatum*	.	.	.	.	.	.	.	+	I	0.06
					Vaccinio-Piceetea										
MPh	E	0	0	0	*Picea abies*	+	+	.	+	.	.	.	+	III	0.25
mPh	Arct-Alp	2.5	1.5	4	*Juniperus sibirica*	+	+	+	.	.	.	.	+	III	0.25
H	Alp-Carp-B	3.5	2	1.5	*Soldanella montana*	+	+	+	+	.	.	.	.	III	0.25
Ch(nPh)	Cp	0	2	1	*Vaccinium myrtillus*	.	.	.	+	.	+	+	+	III	0.25
Ch(nPh)	Cp	3	2	1	*Vaccinium vitis-idaea*	.	+	+	.	.	.	.	.	II	0.12
H	Cp	0	0	1	*Deschampsia flexuosa*	.	.	.	.	.	+	.	+	II	0.12
					Variae syntaxa										
H	Arct-Alp	3	0	0	*Poa alpina*	+	+	+	+	+	.	.	.	IV	0.31
H	Ec	3	2.5	3.5	*Aposeris foetida*	.	+	+	.	.	.	.	.	II	0.12
H	Carp-B	5	2	2	*Pedicularis limnogena*	+	.	.	.	+	.	.	.	II	0.12
H	Carp-B	3.5	2	4.5	*Ranunculus montanus ssp. pseudomontanus*	.	+	+	+	.	.	.	.	II	0.18
H	End	2.5	2	0	*Campanula kladniana*	.	.	.	.	.	+	.	.	I	0.06
G	D	4.5	2	2	*Dactylorhiza cordigera ssp. cordigera*	.	.	.	.	+	.	.	.	I	0.06
H	Cp	4.5	0	1.5	*Eriophorum vaginatum*	.	.	.	.	+	.	.	.	I	0.06
H	End	2	3.5	4.5	*Primula elatior ssp. leucophylla*	.	.	+	.	.	.	.	.	I	0.06
Ch	End	2	3.5	4.5	*Thymus comosus*	.	.	.	+	.	.	.	.	I	0.06

Location and date of surveying: 1- 46°40^{I}976^{II}N, 22°43^{I}524^{II}E Poiana Stânișoara (18.07.2023); 2-4 46°41^{I}186^{II}N, 22°42^{I}993^{II}; 46°41^{I}186^{II}N, 22°42^{I}931^{II}; 46°41^{I}143^{II}N, 22°42^{I}891^{II}E Gruieșu (18.07.2023); 5-46°40^{I}648^{II}N, 22°43^{I}031^{II}E Muntele Briței (18.07.2023); 6-7 46°43^{I}472^{II}N, 22°38^{I}133^{II}E; 46°43^{I}513^{II}N, 22°37^{I}761^{II}E Gruiu Ursului (24.07.2020); 8- 46°40^{I}669^{II}N, 22°38^{I}466^{II}E Baia Popi (24.07.2020).

The edapho-climatic conditions in which the ***Phleo alpini – Deschampsietum caespitosae*** association develops favor the development of mesophilic (46.1%), meso-hygrophilic (17.3%), euryhydric (15.4%), xero-mesophilic (15.3 %) and hygrophilic (5.8%) species (see Figure 4). Regarding the temperature factor, most species are microtherms (48.4%), eurytherms (26.9%), micro-mesotherms (17.3%) and cryophiles (7.6%) (see Figure 4). With regard to the chemical reaction of the soil, most species are euriionic (40.4%), acid-neutrophils (23.1%), acidophiles (17.3%), strongly acidophiles (11.5%) and weakly acid-neutrophils (7.7%) (see Table 2).

able 2

Ecological indices for the *Phleo alpini-Deschampsietum caespitosae* association

Ecological indices		1	1.5	2	2.5	3	3.5	4	4.5	5	0
M	Sp.no	-	-	2	6	11	13	5	4	3	8
	%	-	-	3.8	11.5	21.1	25	9.6	7.7	5.8	15.4
T	Sp.no.	1	3	21	4	8	1	-	-	-	14
	%	1.9	5.7	40.4	7.7	15.4	1.9	-	-	-	26.9
R	Sp.no.	6		9		12		4		-	21
	%	11.5		17.3		23.1		7.7		-	40.4

Legend: M=Soil moisture, T=Air temperature, R=Chemical reaction of the soil

Economic and ecological relevance.

From an economic perspective, pastures with *Phleum alpinum, Deschampsia caepitosa, Festuca rubra ssp. nigriscens, Poa alpina, Trifolium repens ssp. alpinum*, generate a production of green mass (biomass) of roughly 8,000kg/ha, which si the outcome of the coexistence of a nucleus of very good fodder species.

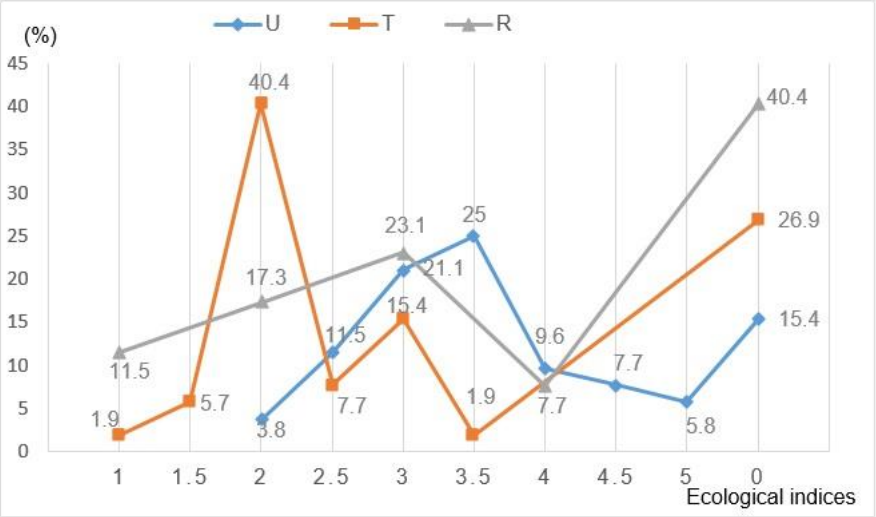

Figure 4. **Diagram of ecological indices for the *Phleo alpini-Deschampsietum caespitosae* association**

Moreover, the presence of the species, *Solnella montana, Pedicularis limnogena*, in this phytocenosis is of great importance since they are included in the Red Book of Vascular Plants of Romania (Dihoru et Negrean, 2009) with conservation status. In the surveyed territory, species considered endemic, Carpatho-Balkan for Romania were found such as: *Thymus comosus, Primula elatior ssp. leucophylla, Campanula kladniana, Ranunculus montanus ssp. pseudomontanus, Viola declinata, Campanula abietina, Hypericum richeri ssp.* grisebachii, which improves the conservation value of the association built by *Phleum alpinum* and *Deschampsia caespitosa*.

CONCLUSIONS

The coenotic biodiversity of the subalpine meadows ***Phleo alpini – Deschapsietum caespitosae*** in the Vlădeasa Mountains is large and diverse, making up a floristic inventory of 52 cormophytes.

The belonging of the surveyed territory to the climate of temperate continental excessive regions is proven by the high presence of microtherms (48.4%), hemicryptophytes - 41 species with a share of 78.8%, and of camaephytes with a share of 9.6%.

The spectrum of floristic elements indicates the dominance of Eurasian species (19.2%) closely followed by circumpolar (17.3%) ones. Due to the large number of Carpatho-Balkan (9.6%), Arcto-Alpine (7.7%), Alpine-Carpatho-Balkan (5.8%), endemic (5.8%), and Alpine-European (3.8%) species, the floristic connections with the Balkan Mountains and the European Alps are thus confirmed.

Analyzing the behavior of the species in terms of ecological factors (M,T,R), the mesophilic (46.1%), microthermic (48.4%) and euriionic (40.4%) nature of the phytocenosis is highlighted.

From economic perspective and productive standing, the meadows built by *Phleum alpinum* and *Deschampsia caespitosa* have a very good fodder value.

The presence of endemic species (*Campanula abietina, Campanula kladniana, Ranunculus montanus ssp. pseudomontanus, Soldanella montana, Thymus comosus, Viola declinata, Primula elatior ssp. leucophylla, Hypericum richeri ssp. grisebachii*), glacial relicts (*Eriophorum vaginatum*), rare, and vulnerable (*Dactylorhiza maculata ssp. maculata, Dactylorhiza cordigera ssp. cordigera, Pedicularis limnogena, Pseudorchis albida*) is also noticed thus providing a conservation and protection status to these phytocenoses within the Apuseni Mountains.

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