THE VEGETATION OF THE SUBALPINE MEADOWS DEVELOPED BY *VIOLA DECLINATA* AND *NARDUS STRICTA* IN THE GILAU MOUNTAINS, CLUJ COUNTY.

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RESEARCH ARTICLE (REVIEW ARTICLE)

Abstract

The lifeforms (see Figure 1) show the dominance of hemicryptophytes (74.19%), followed at a great distance by phanerophytes (11.28%), camaephytes (9.67%), geophytes (3.22%) and therophytes (1.61 %).

In the spectrum of floristic elements (see Figure 2), we may notice the high share of Eurasian species (29.03%), followed by circumpolar (22.58%), European (16.20%), Carpatho-Balkan (12.9%), central European (9.67%), cosmopolitan (6.45%), and Mediterranean (3.22%) species.

The ecological indices diagram (see Figure 3) highlights the predominance of mesophilic species (43.54%), followed by euryhydra (22.58%), xeromesophilic (20.96%) and mezzo-hygrophilic species with (11.28%). With regard air temperature, the majority species are microthermal (38.70%), closely followed by eurythermal (33.88%), micro-mesothermal (17.74%), cryophilic (6.44%) and moderately thermophilic (3.22%) species. As far as the chemical reaction of the soil is concerned, euriionic species are dominant (40.32%), followed by acidophilic (24.19%), acid-neutrophilic (17.74%), strongly acidophilic (11.29%), and weakly acid neutrophils (6.45%) species.

The karyological spectrum (see Figure 4) highlights the predominance of polyploids (46.77%) followed by diploids (30.46%), diplo-polyploids (20.96%), and species of unknown karyotype (1.61%). The diploidy index has a value of 0.65.

Keywords: phytocenoses, lifeforms, floristic elements, ecological indices, karyotype.
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INTRODUCTION

Populations of *Nardus stricta* together with *Viola declinata* occupy large areas on plateaus or on slightly inclined slopes (2-10°) and with different exposures, growing on siliceous soils, short-profile spodisoils, acidic and poorly aerated soils.

Phytocoenoses developed by *Nardus stricta* are quite widespread in the mountain, subalpine and alpine floors, the *Violo declinatae-Nardetum strictae* association being described from the entire Carpathian chain as follows: Penteleu Massif (Serbănescu, 1939), Parang Mountains (Safta, 1943; Buia, 1959), Sebes Valley (Al.Borza, 1959), Bihor Mountains (Simon, 1966), Padis Plateau (Kovács et al., 1966), Rarau Mountains (Raclaru, 1967), Bucegi Mountains (Beldie, 1967), Ceahlau Mountains (Zanoschi, 1971), Siriu Mountain (Dihoru, 1975), Bodoc Mountains (Kovács, 1981), Retezat Mountains (Coldea, 1993), Fagaras Mountains (Stancu, 2005), Suhard Mountains (Costica et al., 2010), Orastie river basin (Vintan, 2014), the northern part of Bihor Mountains (Togor, 2016). The phytocoenoses of the association were found in some places within the the Bihor Mountains, Somesul Cald - Somesul Rece rivers interfluve area: Petreasa, Salha Peak, Pietroasa, Fleiu, Bortita, Marsoaia, Somesul Rece river flood land, Racatau-Dorna Valley.

Type of habitat: R3609 - Southeastern Carpathian pastures with *Nardus stricta* and *Viola declinata*. Correspondences: NATURA 2000: 6230* Species-rich Nardus grasslands, on siliceous substrates in mountain areas; CORINE: Alpic mat-grass swards; EUNIS: E4.31 Alpic *Nardus stricta* swards and related communities; E4.3172 Eastern Carpathian mat-grass swards. Natural habitat of community interest, whose conservation requires the designation of special conservation areas (Donita et al., 2005).

MATERIAL AND METHOD

The material subjected to research consists of the meadows developed by *Nardus stricta* and *Viola declinata*, studied during the years 2018-2019, by surveying within the Western Carpathians (i.e. Apuseni) Mountains, Somesul Cald-Somesul Rece rivers interfluve.

We carried out 10 phytocoenological surveys on the most representative phytocoenoses. All plant species found, with the assessment of abundance and dominance (AD) for each species according to the Braun-Blanquet scale (Braun-Blanquet et Pavillard 1928), were enclosed in the association table (see Table 1). The *Violo declinatae-Nardetum strictae* association was analyzed and characterized ecologically, phytocenologically, cytogenetically based on the association table and histograms with reference to the distribution of lifeforms, floristic elements, ecological indices, and genetic karyotypes.

Finding and description of the association were made based on the floristic criterion, with the help of characteristic, indicator, dominant and differential species. The name of the association is in accordance with the provisions established by the International Code of Phytosociological Nomenclature (Weber et al., 2000). Classification of species by corresponding coeno-taxonomic units (i.e. sub-alliances, alliances, orders, classes) was made in accordance with the ecological-floristic systems elaborated by Tüxen (Tüxen, 1955), and Braun-Blanquet (Braun-Blanquet, 1964), and on the basis of more recent works (Coldea et al., 1997 and Sanda et al., 2003, 2008).

The ecological and phytocoenological characterization of the species within the surveyed territory was made according to dedicated literature (Sanda et al., 2003), (Ciocarlan, 2009), (Sarbu et al., 2013).

The information on the value of ecological indices, lifeforms, floristic elements, and number of chromosomes are presented according to synthesis works elaborated by various researchers (Pop, 1977, 1982), (Sanda et al., 2003, 2008), (Cristea et al., 2004), (Ciocarlan, 2009), (Burescu et Toma, 2005), (Donita et al., 2005).

We carried out the analysis of phytocoenoses with regard the influence of ecological factors moisture (M), temperature (T) and soil chemical reaction (R) according to a previous paper works (Sanda et al., 2003), which adapted the ecological indices values for the plants in Central Europe on a 1 to 9 scale (Ellenberg, 1974) to the pedoclimatic conditions specific to Romania, by making use of scale ranging between 1 and 6. We made the classification of the species by the corresponding coenotaxa according to the works of other authors (Borza et Boscaiu, 1965).

Cytogenetic analysis of species by karyotype thereof was done according to the works of Sanda et al., 2003.

RESULTS AND DISCUSSIONS

The herbaceous layer (see Table 1) includes 62 phytotaxa, showing a high biodiversity.

The dominant and characteristic basic species is *Nardus stricta*, with a coverage of 70.83% ADm and maximum consistency (K=V), and the differential and characteristic species *Viola declinata* has a small coverage of only 0.5%, but a maximum consistency (K=V).

There are highlighted 13 species belonging to the alliance ***Potentillo-Nardion*** (i.e. *Arnica montana, Campanula abietina, Hieracium aurantiacum, Gnaphalium sylvaticum, Carex leporina, Antennaria dioica, Campanula rotundifolia* ssp. *polimorfa, Potentilla ternata, Danthonia decumbens, Campanula serrate, Scorzonera rosea, Hieracium officinarum, Hieracium umbellatum*), two species belonging to the alliance ***Genistion pillosae*** (i.e. *Vaccinium myrtillus, Vaccinium vitis-idaea*), and four species (i.e. *Potentilla erecta, Hypericum macullatum, Luzula sudetica, Festuca nigrescens*) belong to the order NARDETALIA and class **NARDO-CALLUNETEA.** A significant number of species migrated from the neighboring associations, where euriionic species are found, and they belong to the following classes: **MOLINIO-ARRHENATHERETEA** (*Festuca rubra, Agrostis capillaris, Cerastium holosteoides, Orchis ustulata, Trifolium repens, Leontodon hispidus, etc.*), **QUERCO-FAGETEA** (*Veronica officinalis, Hieracium transylvanicum, Trifolium medium, Aconitum lycoctonum ssp. vulparia, etc.*) and **VACCINIO-PICEETEA** (*Deschampsia flexuosa, Picea abies, Laserpitium krapfii, Calluna vularis, Bruckenthalia spiculifolia, Homogine alpine, etc.*).

From the lifeforms' perspective (see Figure 1), the species analysis shows the dominance of hemicryptophytes (74.19%), followed at a great distance by phanerophytes (11.28%), camaephytes (9.67%), geophytes (3.22%), and therophytes (1.61%).

Regarding the share of floristic elements (see Figure 2), one can notice a high percentage of Eurasian species (29.03%), followed by circumpolar (22.58%), European (16.20%), Carpatho-Balkan (12.9%), Central European

(9.67%), Cosmopolitan (6.45%) and Mediterranean (3.22%) species.

The diagram of ecological indices (see Figure 3) shows the dominance of mesophilic species (43.54%), followed by eurihydric (22.58%), xeromesophilic (20.96%), and mezzo-hygrophilic (11.28%) species. Regarding the air temperature, the majority species are microthermal (38.70%), closely followed by eurythermal (33.88%), micro-mesothermal (17.74%), cryophilic (6.44%) and moderately thermophilic (3.22%) species. Following the analysis of the chemical reaction of the soil, euriionic species are dominant (40.32%), followed by acidophilic (24.19%), acid-neutrophilic (17.74%), strongly acidophilic (11.29%), and weakly acidic neutrophils (6.45%) species.

The karyological spectrum (see Figure 4) highlights the predominance of polyploids (46.77%) followed by diploids (30.46%) and diplo-polyploids (20.96%). The diploidy index has a value of 0.65. The economic value of the mat-grass is low, and as far as the pastoral potential of these meadows is concerned, it is small due to the floristic composition encompassing few fodder species. This is due to the unfavorable climatic and vegetation conditions in which coenoses develop and overgrazing in these areas. The meadows have a low conservation value consisting of habitats of priority conservation interest at European level, sheltering several species of protected, endemic, vulnerable and rare plants placed on the Red List (i.e. *Viola declinata, Arnica montana, Campanula rotundifolia ssp. polymorpha, Scorzonela rosea, Campanula serrata, Orchis ustulata*). Through the strong development of the root system, they completely cover the soil, thus preventing its erosion. Figure 1 Spectrum of bioforms in the *Violo declinatae-Nardetum strictae* association

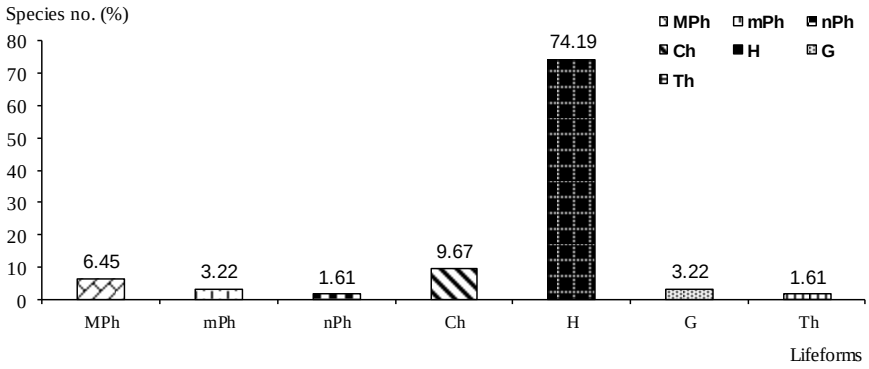

Figure 1 Spectrum of bioforms in the *Violo declinatae-Nardetum strictae* association
Legend: MPh = Megaphanerophytes; mPh = Mesophanerophytes; nPh = Nanophanerophytes; Ch = Chamaephytes; H = Hemicriptophytes; G = Geophytes Th = Annual terophytes.

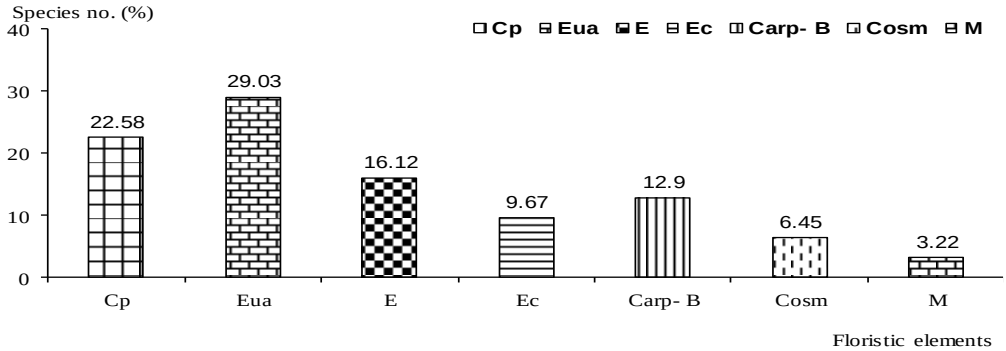

Figure 2 The spectrum of floristic elements from the *Violo declinatae-Nardetum strictae* association
Legend: Cp= Circumpolar; Eua= Eurasian; E= European; Ec= Central European; Carp-B = Carpatho-Balkan; Arct-Alp = Arctic-Alpine; Cosm= Cosmopolitan; M= Mediterranean.

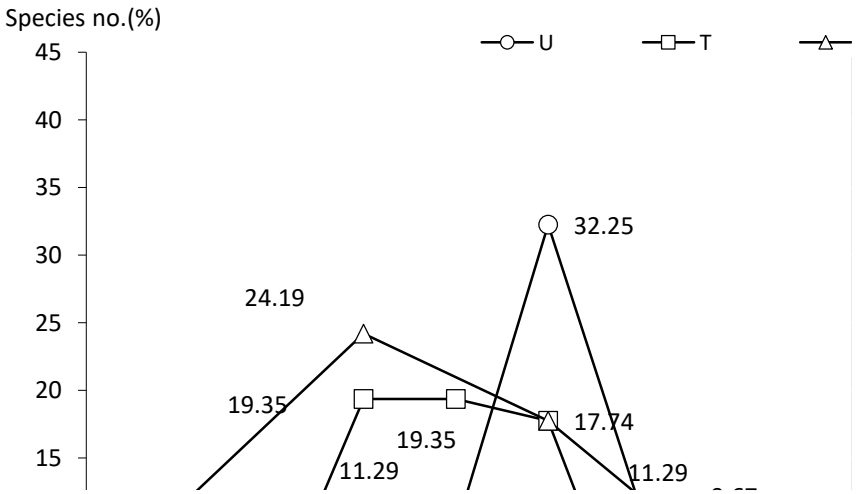

Figure 3. Ecological indices diagram for the *Violo declinatae-Nardetum strictae* association

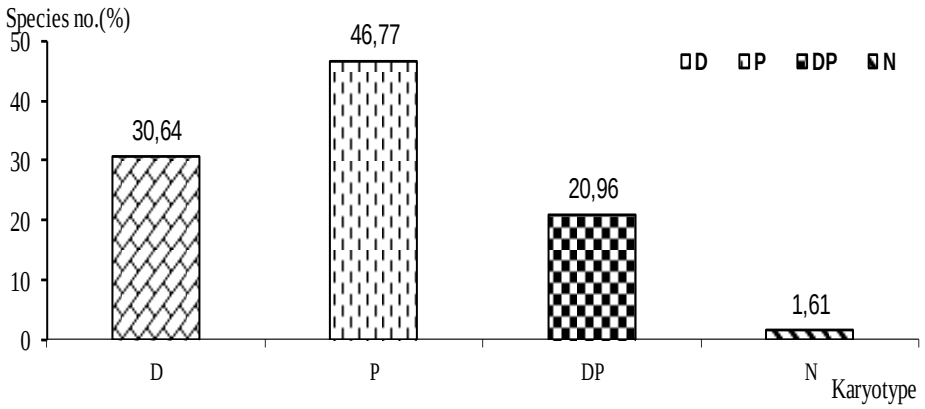

Figure 4. The karyological spectrum for the *Violo declinatae-Nardetum strictae* association
Legend: D = Diploids; P = Polypoids; DP = Dipopoliploids; N = Unknown karyotype.

Table 1

Viola declinatea-Nardetum strictae Simon, 1966

Lifeforms	Floristic elements	M	T	R	G												K	ADm
						Survey no.	1	2	3	4	5	6	7	8	9	10		
						Altitudine (mamsl)	1641	1668	1663	1546	1260	1315	1345	1363	1310	1369		
						Exposure	V	-	E	S	S	V	-	E	-	V		
						Slope (º)	2	-	6	2	10	8	-	4	-	10		
						Grass layer coverage (%)	100	100	100	100	100	100	100	100	100	100		
						Area (sq.m.)	100	100	100	100	100	100	100	200	100	100		
H	Carp-B	3.5	2	2	DP	*As. Viola declinata*	+	+	+	+	+	+	+	+	+	+	V	0.5
H	Eua	0	0	1.5	D	*As. Nardus stricta*	5	5	5	5	4	5	5	5	4	4	V	80
						Potentillo - Nardion												
H	E	3	2.5	3	P	*Arnica montana*	+	+	+	+	+	+	.	+	.	.	IV	0.35
H	Carp-B	3.5	2	2	P	*Campanula abietina*	.	.	+	.	.	+	+	+	+	+	III	0.3
H	Cp	3	3	3	P	*Gnaphalium sylvaticum*	.	+	+	.	+	.	+	+	.	.	III	0.25
H	E	3.5	2	4	P	*Hieracium aurantiacum*	+	+	+	.	.	.	.	.	.	.	II	0.15
H	M	0	3	2	P	*Danthonia decumbens*	.	.	.	.	+	+	+	.	.	.	II	0.15
H	E	2.5	0	0	DP	*Hieracium officinarum*	.	.	.	.	.	+	+	+	.	.	II	0.15
H	Cp	4	2.5	3	P	*Carex leporina*	.	+	.	.	.	.	.	+	.	.	I	0.1
H	Cp	3	1	2.5	P	*Antennaria dioica*	.	+	.	.	.	.	.	.	.	.	I	0.05
H	Cp	2	0	3	DP	*Campanula rotundifolia ssp.polymorpha*	.	.	+	.	.	.	.	.	.	.	I	0.05
H	Carp-B	0	1.5	2	N	*Potentilla ternata*	.	.	.	.	.	.	.	+	.	.	I	0.05
G	Alp-Carp-B	2	0	4	D	*Scorzonera rosea*	.	.	.	.	.	+	.	.	.	.	I	0.05
H	Carp-B	0	2.5	0	DP	*Campanula serrata*	.	.	.	.	.	+	.	.	.	.	I	0.05
H	Cp	2.5	3	0	DP	*Hieracium umbellatum*	.	.	.	.	.	.	.	.	.	+	I	0.05
						Genistion pillosae												
Ch-nPh	Cp-Bo	0	2	1	D	*Vaccinium myrtillus*	+	+	+	+	1	+	+	+	.	2	V	2.6
Ch-nPh	Cp-Bo	3	2	1	D	*Vaccinium vitis idaea*	+		1	1	+	+	.	+	+	+	V	1.35
						Nardetalia et Nardo - Callunetea												
H	Eua	0	0	0	P	Potentilla erecta	+	+	+	+	+	+	1	+	+	+	V	0.95

H	Eua	4	3	2	DP	*Hypericum maculatum*	+	+	+	+	+	+	+	+	+	+	V	0.5
H	Eua	0	2	2	P	*Luzula sudetica*	.	+	.	.	.	.	.	+	.	.	I	0.1
H	E	3	1	2	P	*Festuca nigrescens*	.	.	.	.	.	.	.	1	.	.	I	0.5
						Molinio - Arrhenatheretea													
H	Cp-Bo	3	0	0	DP	*Festuca rubra*	+	+	1	+	+	+	2	.	1	1	V	3.5
H	Cp	0	0	0	P	*Agrostis capillaris*	+	+	.	+	+	.	+	.	.	.	III	0.25
H-Ch	Cosm	3	0	0	P	*Cerastium holosteoides*	.	+	.	+	.	.	+	+	+	.	III	0.25
H	Eua	2.5	2	3	D	*Stellaria graminea*	.	.	.	+	+	.	+	+	+	.	III	0.25
H	Eua	3.5	3	3	D	*Agrostis canina*	.	.	.	.	.	.	.	+	+	+	II	0.15
H	Eua	3.5	0	0	P	*Trifolium repens*	.	.	.	+	.	.	+	.	+	+	II	0.2
G	E	2.5	3	0	DP	*Orchis ustulata*	+	+	+	.	.	.	.	.	.	.	I	0.15
H	Eua	2.5	0	0	DP	*Leontodon hispidus*	.	.	+	.	.	.	.	+	.	.	I	0.1
H-Ch	E	3	3	3	P	*Polygala vulgaris*	.	.	.	.	.	+	.	.	.	.	I	0.05
H	Cosm	4	0	0	DP	*Deschampsia cespitosa*	.	.	.	.	.	.	.	+	.	.	I	0.05
H	Cosm	3	0	0	P	*Poa platensis*	.	.	.	.	.	.	.	+	.	.	I	0.05
H	Cosm	4.5	3	3	P	*Juncus effusus*	.	.	.	.	.	.	.	.	+	.	I	0.05
H	Ec	3	2.5	3	D	*Centaurea phrygia*	.	.	.	.	+	+	.	.	.	.	I	0.1
H	Eua	0	0	0	P	*Anthoxanthum odoratum*	.	.	.	.	+	+	.	.	.	.	I	0.1
Th	E	3	3	0	P	*Euphrasia stricta*	.	.	.	.	.	.	+	.	.	.	I	0.05
H	Eua	0	3	0	DP	*Briza media*	.	.	.	.	+	.	.	.	.	.	I	0.05
H-Ch	Eua	3	0	0	P	*Veronica chamaedrys*	.	.	.	.	.	.	+	.	.	.	I	0.05
H	Eua	0	0	0	D	*Plantago lanceolata*	.	.	.	.	.	.	+	.	.	.	I	0.05
						Querco - Fagetea													
Ch	Eua	2	2	2	P	*Veronica officinalis*	.	+	+	.	+	.	+	+	+	+	IV	0.35
H	Carp-B	3	0	0	D	*Hieracium transylvanicum*	+	+	+	.	+	+	.	.	.	.	III	0.25
H	Eua	3	3	0	P	*Trifolium medium*	.	.	.	.	+	.	+	.	.	.	I	0.1
H	Ec	4	2.5	4	D	*Aconiutum lycoctonum ssp.vulparia*	.	.	.	.	+	.	.	.	.	.	I	0.05
H	Ec-M	3	2.5	3	P	*Senecio ovatus*	.	.	.	+	.	.	.	.	.	.	I	0.05
MPh	Eua	3	2	2	P	*Betula pendula*	.	.	.	.	+	.	.	.	.	.	I	0.05
MPh	Eua	3	2	2	DP	*Populus tremula*	.	.	.	.	+	.	.	.	.	.	I	0.05
H	Eua	3	2.5	0	D	*Fragaria vesca*	.	.	.	.	.	.	+	.	.	.	I	0.05
						Vaccinio - Piceetea													
H	Cp	2	0	1	P	*Deschampsia flexuosa*	+	+	+	1	1	+	+	1	1	1	V	2.75
MPh	E	0	0	0	D	*Picea abies*	+	.	.	.	+	+	+	+	.	+	III	0.25
H	Ec	0	0	3	D	*Laserpitium krapfii*	+	.	1	+	+	.	.	.	.	+	III	0.7
Ch	Atl-Ec	0	0	1	D	*Calluna vulgaris*	+	.	.	+	.	.	.	.	+	.	II	0.1
nPh	Carp-B-Anat	2.5	2.5	1.5	P	*Bruckenthalia spiculifolia*	+	.	.	+	.	.	.	.	.	.	I	0.1
H	E	3.5	2.5	2.5	P	*Homogyne alpina*	.	+	.	.	.	.	.	.	.	.	I	0.05
mPh	Cp-Bo	2	0	0	D	*Juniperus communis*	.	.	.	.	.	.	+	+	.	.	I	0.1
MPh	E	3	2.5	2	D	*Sorbus aucuparia*	.	.	.	.	+	.	.	.	.	.	I	0.05
H-G	Cp	3	2	2.5	D	*Moneses uniflora*	.	.	.	.	+	.	.	.	.	.	I	0.05
Ch	Cp-Bo	5	2.5	1	P	*Lycopodium annotinum*	.	.	.	.	.	.	.	+	.	.	I	0.05
						Variae syntaxa													
Ch	MP	2	4	0	DP	*Thymus glabrescens*	.	.	.	.	+	+	+	.	.	.	II	0.15
mPh	Carp-B-Sudet	4	2	2	D	*Salix silesiaca*	.	.	.	.	.	.	.	+	.	+	I	0.1
H	Eua	2	4	4	D	*Scabiosa ochroleuca*	.	.	.	.	+	.	.	.	.	.	I	0.05
H	Ec	3.5	2.5	0	P	*Knautia dipsacifolia*	+	.	+	.	.	.	.	.	.	.	I	0.1
H	Cp	4	1.5	0	P	*Epilobium anagallidifolium*	.	+	.	.	.	.	.	.	.	.	I	0.05

Location and date of surveys: 1. Petreasa (Franturi), 06.08.2018, GPS 463257,6, 225847,5; 2-3. Salha Peak, 06.08.2018, GPS 463309,2, 230000, 463303,2, 230009,3; 4. Pi 06.08.2018, GPS 463251,1, 225807, 463259, 225742,9; 5-6. Fleiu, 07.08.2018, GPS 463109,7, 225207,9, 463126,2, 225210,5; 7. Marsoaia, 14.09.2018, GPS 463220,4, 2251 Somesul Rece river flood land, 22.07.2019, GPS 463220,1, 230351,3,; 9-10. Racatau-Dorna Valley, 10.08.2019,GPS 463342,6, 230245,1, 463346,9, 230315,5.

CONCLUSIONS

1. Formation of the association encompasses 62 phytotaxa which, considering the difficult development conditions, proves a high biodiversity.
2. Analysis of lifeforms shows the dominance of hemicryptophytes (74.19%).
3. With regard the share of floristic elements, one can notice a high percentage of Eurasian species (29.03%).
4. The diagram of ecological indices highlights the predominance of mesophils (43.54%), euryhydric (22.58%), microthermal (38.70%), eurythermic (33.88%), euryionic (40.32%) and acidophilic (24.19%) species.
5. The association shelters six plant species considered to be protected, endemic, vulnerable and rare, being included on the Red List (i.e. *Viola declinata, Arnica montana, Campanula rotundifolia ssp. polymorpha, Scorzonela rosea, Campanula serrata, Orchis ustulata*).

REFERENCES

Beldie, A., 1967. Endemisms and Dacian elements in the flora of the Romanian Carpathians, Comunicări Botanice magazine, SSNG, 113-130;

Borza, Al., 1959. The flora and vegetation of the Sebeş valley, Romanian Academy Publishing House, Bucharest, 326 p.;

Borza, Al., Boşcaiu, N., 1965. Introduction in the study of the living soil cover, RomaniaEdit. Acad. R.P.R., Bucharest, 340 p.;

Borhidi, A., 1971. *Die Zönologie der Fichtenwälder von Ost-und Südcarpaten*, Acta Bot. Hung., **17**, Budapest, 3-4:287-319;

Braun-Blanquet, J., 1964. Pflanzensoziologie, ed.III Springer-Verlag, Wien-New York.

Braun-Blanquet, J., Pavillard, G., 1928. Vocabulaire de sociologie végétale, ed.II, Imprimerie Roumegous & Dehan, Montpellier;

Buia, Al., Păun, M., Safta, I., Pop,M., 1959. Geobotanical contributions on the pastures and hayfields of Oltenia. Scientific papers of Agricultural Institute "Tudor Vladimirescu", Craiova, 93-183;

Burescu, P., Toma, I., 2005. Manual of practical works in botany, Oradea University Press, Oradea, 590 p.;

Ciocârlan, V., 2009. Iustrated flora of Romania: Pteridophyta et Spermatophyta, Ceres Publishing House, Bucharest, 1141 p.;

Coldea, Gh., Plămadă, E., 1970. Contributions to the study of the class Scheuchzerio-Caricetea fuscae Nordh. 1936, in Romania (I), Hydrobiology, Bucharest, 11:105-116;

Coldea, Gh., 1991. Prodrome des associations végétales des Carpates du Sud-Est (Carpates Roumaines), Documents Phytosociologiques, N.S., XIII, Camerino, 317-539;

Coldea, Gh., 1993. Cormophytes. Syntaxonomy and description of plant associations in Retezat National Park. Ecological studies, Editor I. Popovici, Brasov, 1992, 31-48;

Coldea, Gh., Sanda, V., Popescu, A., Ştefan, N., 1997. Les associations végétales de Roumanie. Tome I: Les associations herbacées naturelles, Edit. Presa Universitară Clujeană, Cluj-Napoca, 261 p.;

Costică, M., Ştefan, N., Sârbu, I., 2010. Contribution to the study of the wood vegetation from the Suhard Mountain, Analele Univ. „Al.I.Cuza", s.II Biologie Vegetală, Iaşi, **56**, 1:65-81;

Cristea, V., Gafta, D., Pedrotti, F., 2004. Fitosociologie (Phytosociology), Cluj Napoca University Press, Cluj-Napoca, 396 p.;

Dihoru, Gh., 1975. Living soil cover in Siriu Mountain, Romanian Academy Publishing House, Bucharest, 216 p.;

Doniţă, N., Popescu, A., Paucă-Comănescu, M., Mihăilescu, M., Biriş, I.A., 2005. Habitats in Romania, Editura Tehnică Silvică Publishing House, Bucharest, 496 p.;

Kovács, A., Coman, N., Peterfi, Şt., 1966. Phytocenological research on the Padiş Plateau Studia Univ. „Babeş-Bolyai", Biololy series, f.1, Cluj-Napoca, 33-41;

Kovács, A., 1981. Flora and vegetation of the Bodoc Mountains, Aluta. Studies and Communications Covasna County Museum, Sfantu Gheorghe, 11-13:363-405;

Ellenberg, H., 1974. Zeigerwerte der Gefässpflanzen Mitteleuropas, Scripta Geobotanica, Göttingen, 9:1-97;

Pop, I., 1977. Ecological biogeography, vol. I. Dacia Publishing House, Cluj-Napoca;

Pop, I., Hodişan, I., Raţiu, O., Cristea, V., Marcu, A., 1984. The study of spruce-beech and mountain spruces along the course of the Somesul Rece river valley (Cluj county), Botanical contributions, Cluj-Napoca, 75-83;

Raclaru, P., 1967. The vegetation of the meadows of the Rarău Massif, Communications on Botany, 5th Conference on Geobotany, Bucharest, 143-178;

Safta, I., 1943. Geobotanical research on Transylvanian pastures, Bulletin of Faculty of Agronomy of Cluj, Timisoara, 10:3-107;

Sanda, V., Biţă-Nicolae, C., Barabaş, N., 2003. The flora of spontaneous and cultivated cormophytes from Romania, „Ion Borcea" Publishing House, Bacau, 316 p.;

Sanda, V., Öllerer, K., Burescu, P., 2008. Phytocoenoses from Romania. Syntaxonomy, structure, dynamics and evolution. „Ars Docendi" Publishing House, Bucharest, 570 p.;

Simon, T., 1966. Beiträge zur kenntnis der vegetation des Bihar (Bihor)-Gebirges, Annales Univ. Scient. Budapest., sect. Biol., Budapest, 8, 253-273;

Stancu, I.D., 2005. The flora and vegetation of the Raiosu and Buda Mountains, the Fagaraş Massif Pitesti University Press;

Sârbu, I., Ştefan, N., Oprea, A., 2013. Vascular plants from Romania: Illustrated determinants collected in the field, Victor B Victor Publishing House, Bucharest, 1320 p.;

Togor ,G.C., 2016. The flora and vegetation of the northern part of the Bihor Mountains, PhD thesis, University of Oradea, 496 p.;

Tüxen, R., 1955. Das System der nordwestdeutschen Pflanzengesellschaften, Mitt. Florist.-Soz. Arbeitsgem. N. F., 5:155-176;

Vințan, V. I., 2014. The flora and vegetation of the Orastie river basin PhD Thesis, University of Oradea, Oradea, 627p.;

Weber, H.E., Moravec, J., Theurillat, J.P., 2000. International Code of Phytosociological Nomenclature, 3 ed., Journal of Vegetation Science, Uppsala, 739-768;

Zanoschi, V., 1971. A contribution to the knowledge of the vegetation of the Ceahlău Massif, Biological research and studies, Botanical Series, Bucharest, 23, 4:347-3.