PHYTOCOENOLOGY AND ECOLOGY OF THE *NARDUS STRICTA* MEADOWS EDIFIED BY *NARDUS STRICTA* AND *VIOLA DECLINATA* IN SEMENIC MOUNTAINS

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Abstract

The mountain meadows of Nardus stricta and Viola declinata are spread over peaks and slopes with various exposures on oligobasic, very acidic, moist, wet siliceous rocks in the Northern part of the Semenic Mountains. In terms of the floristic composition, they have a relatively rich biodiversity, comprising 67 species. In the phytocoenoses of the Violo declinatae – Nardetum association, in terms of the bioforms categories, the predominant ones are hemicryptophyte species (71.64%), followed by phanerophytes (13.41%) and camephytes (7.46%). In the spectrum of phytogeographical elements, Eurasian species are predominant (47.76%), followed by European (14.92%), circumpolar, (10.44%), Carpathian-Balkan, Central European (4.47%), cosmopolitan species (7.46%). As regards the ecological factors: humidity (U), temperature (T), chemical reaction of the soil (R), the predominant ones are mesophiles (37.31%), followed by xero-mesophiles (31,33%), euryhydric (20.89%), microthermal (32.83%), eurythermal (32.83%), micro-mesothermal (28.35%), euryionic (47.76%), acidophilic species (7.46%). Cytogenetic analysis reveals the preponderance of polyploid species (38.82%) and diploid ones (35.82%). Meadows of Nardus stricta and Viola declinata have a high ecological value in that they shelter two endemic endangered species (Campanula serrata, Campanula rotundifolia subsp. polymorpha) and have anti-erosion and climate control ecoprotective functions.

Key words: meadows, phytocoenosis, bioforms, floristic elements, karyotype

INTRODUCTION

Meadows of *Nardus stricta* and *Viola declinata* vegetate acidic, oligotrophic soils with variable humidity of the districambosol type having in depth a substrate of rocks – crystalline schists. The landscape is slightly fragmented, with slightly to moderately inclined slopes (4º-22º) with a predominantly Northern exposure at an altitude ranging from 850 to 1350 m. No researches on herbaceous vegetation, and especially on meadows with *Nardus stricta*, have been carried out in the investigated territory. The first information regarding the flora and vegetation of the Semenic Mountains is found in the work of the great botanist Professor Borza (1941). Other researches carried out in the studied territory or in the surroundings thereof belong to authors Buia (1963), Peia (1978).

MATERIAL AND METHOD

The researched material are the *Nardus stricta* and *Viola declinata* natural grassland ecosystems on the plateau and the heights of the Northern part of the Semenic Mountains on the upper mountain floor. A number of 14 phytocenological elevations (surveys) of the most representative phytocoenoses were performed. All plant species identified were included in the association table, with an assessment of the abundance and dominance (AD) of each one individually, according to the Braun-Blanquet and Pavillard scale (1928). The population of *Nardus stricta* meadows with *Viola declinata* was analyzed and characterized in ecological, phytocoenological, cytogenetic terms, on the basis of the association table and the histograms referring to the distribution of bioforms, the distribution of phytogeographical elements, the distribution of ecoforms and of genetic kariotypes. The classification of the species into types of bioforms was done according to the system developed by Raunkiaer in 1937 and improved by Braun-Blanquet in 1964, Warming (e.g. Borza and Boşcaiu in 1968), and he was the one who introduced the term "life form"). The analysis of composition by floristic elements and their historical, phytogeographical and ecocoenotic significance was done according to Meusel and Jäger (1992), who were the leading representatives of the Central European chorology school.

The analysis of phytocoenoses regarding the ecoform categories of humidity (U), temperature (T) and chemical reaction of the soil (R) was performed according to the works of authors Csürös *et al.* (1967), Beldie, Chiriţă (1967), Sanda et al. 1983, 2003, which adjusted ecological index values for plants in Central Europe on a scale of 1 to 9 according to Ellenberg (1979) to the pedo-climatic conditions specific to Romania, using a scale of values between 1 and 6. The classification of the species into the corresponding coenotaxa was done according to the works of authors Sanda *et al.* (2008), Chifu *et al.* (2014). The cytogenetic analysis of the species by karyotype was done according to the works of authors Ciocârlan (2009), Sanda et al. (2003).

RESULTS AND DISCUSSION

The *Nardus stricta* and *Viola declinata* grassland flora inventory, the *Violo declinatae – Nardetum* association sum up 67 species (Table 1), showing great biodiversity, of which 23 species are part of the *Potentillo-Nardion, Nardetalia* (10 species), *Nardo-Callunetea* (13 species) basic coenotaxa in which the association is included, and 2 species are rare,

endangered, vulnerable and Carpathian endemites according to the red list Boşcaiu et al. (1994), Dihoru *et al.* (1994), Dihoru and Negrean (2009), Oltean et al. (1994), Sârbu coord. (2007).

The herbaceous layer has a coverage of 90-100% due to the explosive regeneration of the *Nardus stricta* plant, which has low fodder value, close to 0, being very poor in quality, therefore, avoided by animals. *Nardus stricta,* being a highly acidophilic species, is favoured in colonizing the land and in forming a compact grassy layer. Additionally, a relatively small number of species of the *Molinio-Arrhenatheretea, Vaccnio-Piceetea* and *Festuco-Brometea* classes may be encountered, which have a certain tolerance to soils with strongly acid pH and poor in mineral salts, from a phytocoenological standpoint (Figure 1).

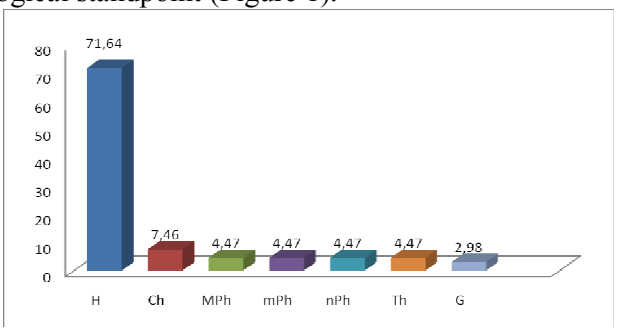

Fig 1 Spectrum of bioforms in the *Violo Declinatae – Nardetum* association
Legend: H=Hemicryptophytes; Ch=Chamaephytes; Mph=Megaphanerophytes; mPh= Megaphanerophytes; nPh=Nanophanerophytes; Th = Therophytes (annual); G=Geophytes.

The *Nardus stricta* and *Viola declinata* meadows are dominated, in terms of types of bioforms, by hemicryptophyte species (71.64%), phanerophytes (13.41%), accompanied by camephytes (7.46%), therophytes (4.47%) and geophytes (2.98%).

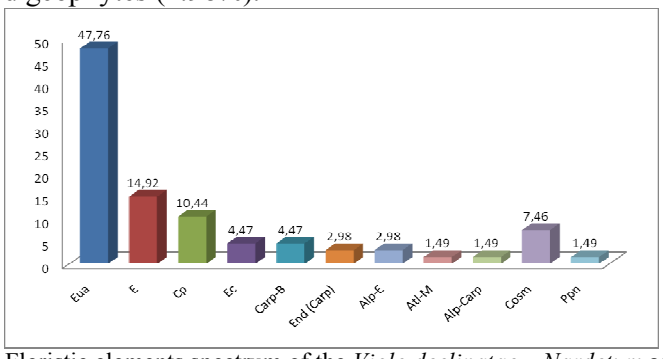

Fig. 2 Floristic elements spectrum of the *Violo declinatae – Nardetum* association
Legend: Eua = Eurasian; E = European; Cp = Circumpolar; Ec = Central European; Carp = Carpathian; End = Endemic;Alp-E=Alpine-European; Atl-M = Atlanto-Mediterranean; Alp Carp=Alpine-Carpathian; Cosm = Cosmopolitan;. Ppn = Pontic-Pannonic.

In terms of the geographical areal and the current distribution of the species (Figure 2), the phytocoenoses of the *Violo declinatae – Nardetum* association are dominated by Eurasian species (47.76%), European (14.92%), circumpolar (10.44%), Carpathian Balkan (4.47%), Central European (4.47%), cosmopolitan species (7.46%). Small percentages of Alpine-European (2.98%), endemite (2.98%), Atlantic-Mediterranean (1.49%), Ponto-Pannonic (1.49%) species have emerged.

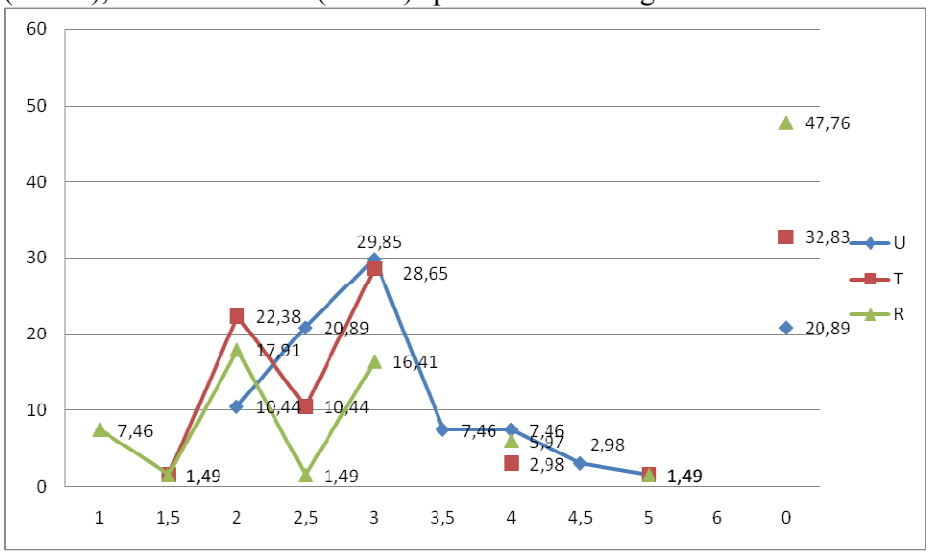

Fig. 3 Ecological indices chart for the *Violo declinatae – Nardetum* association

The analysis of ecoforms (Figure 3) shows that, in relation to soil humidity, mesophilic species (37.31%) predominate, followed by xero-mesophilic (31,33%) and euryhydric ones (20.89%).

Depending on temperature, microthermal (32.83%) and eurythermal species (32.83%) predominate, closely followed by mesothermal ones (28.35%).

As regards the soil's chemical reaction, euryionic species (47.76%), acidophilic species (19.40%) and acidophilic plants (7.46%) are noted.

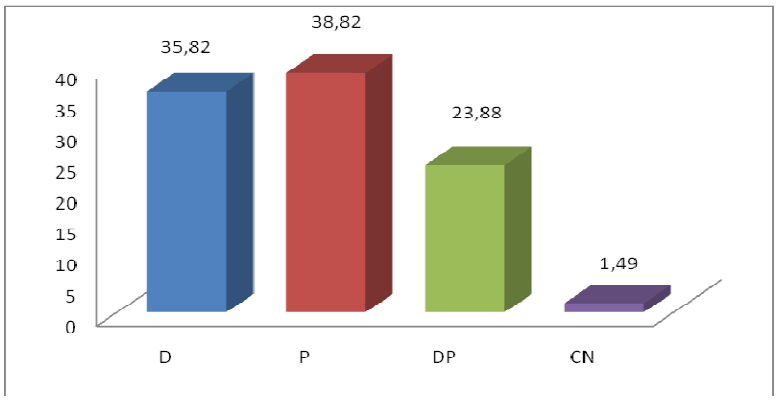

Fig.4 The karyologic spectrum of the *Violo declinatae – Nardetum* association

Legend: D = Diploid; P = Polyploid; DP = Diplo-polyploid; UK = Unknown karytype

As regards genetic categories (Figure 4), in *Nardus stricta* and *Viola declinata* meadows, polyploid species (38.82%) assert themselves, which are better adapted to the pedoclimatic conditions, followed by diploids (35.82%), which constitute the genetic reserve for evolution, diplopolyploids (23.88%) and plants with an unknown karyotype (1.49%)

IMPORTANCE

The *Nardus stricta* and *Viola declinata* meadows are of no importance in terms of fodder value. They vegetate in a natural habitat of Community interest, code 3609, whose protection requires the declaration of special conservation areas - Doniţă *et al*. (2005), Gafta et Mountford (2008) - and are included in a natural ecosystem, where two rare endemic species have found refuge: *Campanula serrata* and *Campanula rotundifolia ssp. polymorpha*. The *Nardus stricta* and *Viola declinata* meadows have an important role in controlling soil erosion, protecting river basins and climate control. *Nardus stricta* meadows with *Viola declinata* in the Northern part of the Semenic Mountains increase the tourist attractiveness of the studied area through the diversity and specificity of the landscape.

Table 1

Violo declinatae-Nardetum Simon 1966
(Syn:*Nardetum strictae montanum* Resmeriţă and Csürös 1963)

Biof.	E.fl	U	T	R	C	No. of survey (relevé)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
						Altitude (meters above sea level)	958	974	1383	1442	1025	964	965	1080	1012	850	940	1080	980	1350	
						Exposure	S	SE	SW	SW	E	SE	SE	E	SE	W	N	N	NE	SE	K
						Slope gradient(^{0})	18	15	10	22	6	16	17	10	10	20	20	4	15	20	
						Vegetation coverage (%)	100	100	100	100	100	100	100	100	100	100	90	90	100	90	
						Area being analyzed (m^2)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
						Car.ass															
H	Carp-B	3,5	2	2	DP	*Viola declinata*	1	2	2	3	1	1	3	2	4	1	3	2	1	4	V
H	Eua	0	0	1,5	D	*Nardus stricta*	4	5	4	4	4	4	5	5	3	3	3	4	2	2	V
						Nardetalia, Potentillo-Nardion															
H	Eua	4	3	2	D	*Hypericum maculatum*	-	+	+	-	-	+	-	-	+	+	+	-	-	-	III
TH	E	3	2,5	3	D,P	*Campanula patula*	+	+	-	-	+	-	+	+	+	+	-	-	-	-	III
TH	Carp-B	3,5	2	2	P	*Campanula abietina*	+	-	+	-	-	+	-	+	-	+	-	+	+	-	III
H	Eua	3	2	2	DP	*Cruciata glabra*	-	+	-	-	-	-	+	-	+	+	-	-	-	-	II
H	End(Carp)	0	2,5	0	D	*Campanula serrata*	-	-	+	1	-	-	-	-	-	-	-	-	-	-	I
H	Eua	3,5	2	3	P	*Hieracium aurantiacum.*	-	-	-	-	-	-	-	-		1	-	-	-	-	I
H	Carp-B	0	1,5	2	-	*Potentilla ternata*	-	-	+	-	-	-	-	-	-	-	-	-	-	-	I
H	End(Carp)	2,5	2	0	DP	*Campanula rotundifolia subsp.polymorpha*	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I
H	Eua	3	3	2	P	*Hieracium laevigatum*	-	-	-	-	-	-	-	-	-	+	-	-	-	-	I
H	Alp-E	3	2	0	P	*Phleum alpinum*	-	-	-	+	+	-	-	-	-	-	-	-	-	+	I
						Nardo-Callunetea															
H	Cp	2	0	1	P	*Deschampsia flexuosa*	+	+	1	1	+	+	+	+	-	1	1	+	+	+	V
H	Eua	0	0	0	P	*Potentilla erecta*	+	+	-	+	+	+	-	-		+	+	+	+	+	IV
nPh	Cp	3	2	1	D	*Vaccinum vitis-idaea*	-	-	+	+	-	+	+	-	-	+	+	+	+	+	IV
nPh	Cp	0	2	1	D	*Vaccinum myrtillus*	+	-	2	3	-	+	+	+	1	+	+	-	+	+	IV
H	E	3	0	3	D	*Luzula campestris*	-	+	-	1	+	+	+	+	-	+	-	-	+	-	III
H	Ec	2,5	4	3	P	*Danthonia decumbens*	+	+	-	-	+	+	+	+	-	+	-	-	-	-	III
H	E	2	3	2	P	*Hieracium maculatum*	-	-	-	-	+	+	-	-	+	+	-	-	-	-	II
H	E	2,5	0	0	DP	*Hieracium pilosella*	-	-	-	-	-	-	+	-	-	-	-	+	-	+	II
Ch	Eua	2	2	2	DP	*Veronica officinalis*	-	-	-	-	+	-	-	-	+	+	-	+	-	-	II

Table 1 - continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
H	Cp	2,5	3	2,5	DP	*Hieracium umbellatum*	-	-	+	-	-	+	-	-	-	-	-	-	-	-	I
Ch	Cosm	3	3	1	P	*Lycopodium clavatum*	-	-	-	+	-	-	-	-	-	-	+	-	-	-	I
G	Eua	0	0	1	P	*Calluna vulgaris*	-	-	+	-	-	-	-	-	-	-	-	-	-	-	I
H	Atl-M	3	3	3	P	*Genistella sagittalis*	-	-	-	-	+	-	-	-	+	-	+	-	-	-	I
						Molinio-Arrhenatheretea															
H	Cp	3	0	0	DP	*Festuca rubra*	2	1	2	1	2	1	1	1	2	2	1	2	2	2	V
H	Cp	0	0	0	P	*Agrostis capillaris*	2	1	1	-	1	2	1	-	1	+	-	+	-	-	IV
H	Eua	3,5	3	0	D	*Holcus lanatus*	+	+	-	-	+	+	+	+	+	-	+	-	-	+	IV
H	Eua	2,5	2	3	P	*Stellaria graminea*	+	+	+	-	+	+	-	+	-	-	-	+	-	-	III
H	Eua	0	0	0	DP	*Anthoxanthum odoratum*	-	+	-	-	+	-	+	+	+	+	-	-	+	-	III
H	Eua	3	0	3	D	*Galium mollugo*	-	+	-	-	-	-	-	-	+	+	-	-	-	-	II
G	Eua	4	2,5	4	D	*Veratrum album*	-	-	+	-	-	+	-	-	+	-	-	-	+	-	II
H	Eua	2,5	0	0	D	*Leontodon hispidus*	-	-	+	-	+	-	-	-	-	-	-	+	-	+	II
nPh	Ec	2,5	3	0	P	*Cytisus nigricans*	-	-	+	-	-	-	+	-	+	-	-	-	-	-	II
TH	Eua	2,5	3	0	D	*Viola tricolor*	-	+	-	+	+	+	+	-		-	-	-	-	-	II
H	Cosm	3	3	0	D	*Rumex acetosa*	-	-	-	+	+	+	-	-	+	-	-	-	-	-	II
H	Eua	3	0	0	P	*Achillea millefolium*	-	+	-	-		+	+	-	+	-	-	+	-	-	II
H	Eua	3	3	0	D	*Stachys officinalis*	-	-	-	-	+	-	-	-	-	-	-	+	+	-	II
H	Eua	0	0	0	DP	*Succisa pratensis*	-	-	-	-	-	+	-	-	-	-	-	-	-	-	I
H	Eua	3	0	0	DP	*Leontodon autumnalis*	-	-	-	-	+	-	-	-	-	-	-	-	-	-	I
Ch	Cosm	3	0	0	P	*Cerastium holosteoides*	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I
H	Eua	4	3	0	P	*Molinia caerulea*	-	-	-	-	-	-	-	+		-	2	-	-	-	I
H	Eua	0	0	0	D	*Plantago lanceolata*	-	-	-	+	-	-	-	-	-	-	-	+	-	-	I
H	Cosm	4,5	3	3	P	*Juncus effusus*	-	-	-	-	+	-	-	-	-	-	-	-	-	+	I
H	Eua	2,5	3	3	D	*Ranunculus polyanthemos*	-	+	-	-	-	-	-	-	-	-	-	-	+	-	I
H	Eua	2,5	3	3	D	*Ranunculus polyanthemos*	-	+	-	-	-	-	-	-	-	-	-	-	+	-	I
						Vaccnio-Piceetea															
H	E	2,5	2,5	2	D	*Luzula luzuloides*	-	-	+	-	-	+	-	-	+	+	+	+	-	+	III
mPh	E	3	2,5	2	D	*Sorbus aucuparia*	-	-	-	-	-	-	+	+	-	-	+	-	-	-	II
H	Eua	2	3	0	P	*Calamagrostis arundinacea*	-	-	-	-	+	-	+	-	+	-	-	-	-	+	II

Table 1 - continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
H	Eua	0	2	2	D	*Luzula sudetica*	-	+	+	-	-	-	+	-	-	-	-	+	-	-	II
mPh	Cp	2	0	0	D	*Juniperus communis*	-	+	-	-	+	-	-	+	-	+	+	-	-	-	II
Mph	Eua	3	2	2	P	*Betula pendula*	+	-	-	-	-	-	-	+	+	+	+	-	-	-	II
MPh	E	0	0	0	D	*Picea abies*	-	-	-	+	-	-	-	+	-	-	-	-	-	-	I
						Festuco-Brometea															
Ch	Ppn	2	4	0	P	*Thymus glabrescens*	-	+	-	-	+	+	+	+	-	-	+	-	-	-	III
H	E	2	5	5	D	*Dianthus carthusianorum*	-	+	-	-	-	+	+	-	-	-	-	-	-	-	II
H	Alp-Carp	2, 5	2	0	P	*Festuca picta*	-	-	1	-	-	-	-	-	-	-	-	-	+	-	I
						Variae Syntaxa															
H	Eua	3	3	4	D P	*Brachypodim sylvaticum*	+	+	+	-	-	+	-	-	-	-	-	-	-	-	II
H	Eua	4, 5	0	4	P	*Agrostis gigantea*	-	-	-	-	-	-	+	-	-	+	+	-	-	-	II
H	Cosm	4	0	0	D P	*Deschampsia caespitosa*	-	-	-	-	-	-	+	-	+	+	-	-	-	-	II
H-Hh	Eua	5	0	0	P	*Lysimachia vulgaris*	-	-	-	+	-	+	-	-	-	+	-	-	-	-	II
MPh	E	3	3	0	D	*Fagus sylvatica*	+	-	-	-	-	-	-	+	-	-	-	-	-	+	II
H	Eua	3	2,5	0	D	*Fragaria vesca*	-	+	-	-	-	-	+	-	-	-	+	-	-	-	II
H	Eua	0	0	0	D	*Succisa pratensis*	-	-	-	+	-	+	-	-	-	--	+	-	--	-	II
H	E	2	3	2	P P	*Hieracium maculatum*	-	-	+	-	-	-	-	-	+	-	-	-	+	-	II
Ch	E	2, 5	3	3	D P	*Thymus pulegioides*	-	-	-	-	-	-	-	-	-	-	-	+	+	-	I
H	Alp-E	3, 5	2	0	D P	*Rumex alpinus*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	I
mPh	Eua	2, 5	3	3	D	*Crataegus monogyna*	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I
H	Ec	4	2	4	P	*Gentiana asclepiadaea*	-	-	+	-	-	-	-	-	+	-	+	-	-	-	I

Place and date of performance of the surveys (relevés): 1 - Near the sculpture park of Gărâna (Caraş-Severin county) 12th August 2016; 2 – Cucuiul cu Pietricele - right side Slatina Timiş – Brebu Nou 13th June 2016; 3 - Semenic Mountains Plateau - 12th August 2016: 4 - Under the Piatra Goznei Peak -10th August 2016; 5 - Right side towards Cuca Vălugenilor beyond Tâlvă -13th June 2016; 6 - Near the sculpture park of Gărâna (Caraş-Severin county) 12th August 2016; 7 - Towards Cucuiul cu pietricele - right side from Slatina Timiş-Brebu - 13th June 2016; 8 - Towards Cuca Vălugenilor - Valdivar Peak - 13th August 2018; 9 - Right side Slatina Timiş - Brebu Nou beyond Tâlva Valdivar - 13th August 2016; 10 - Left side Slatina Timiş - Brebu Nou near the Television relay – 11th June 2016; 11 - Near Cuca Vălugenilor - 13th August 2016; 12 - Near the Gărâna Television Relay - 12th August 2016; 13 - On the plateau, next to the Gărâna television relay -12th August 2016; 14 - Under Piatra Goznei Peak - 10th August 2016.

CONCLUSIONS

1. Through the study performed, we identified 67 species of which 2 endangered endemic species.

2. In the phytocoenoses of the *Violo declinatae – Nardetum* association, hemicrypthophyte species (71.64%) predominate in number and percetange, as a consequence of the fact that the territory surveyed belongs to the temperate continental climate region.

3. As regards the geographical areal and the genetic centre of origin, the fund of phytogeographical elements is dominated by Eurasian species (47.76%), followed by European (14.92%) and circumpolar-boreal (10.44%) ones.

4. As regards the action of ecological factors, humidity, temperature, chemical reaction of the soil, the meadows of the *Violo declinatae – Nardetum* association have a mesophilic (37.31%), microthermal (32.83%), eurythermal (32.83%), and euryionic (47.76%) character.

5. As regards genetic constitution in the phytocoenoses of the *Viola declinatae – Nardetum* association, polyploid species predominate (38.88%), which favour the colonization of the space and adaptation to the environmental conditions, followed by the diploid ones, which store the gene reserve necessary for evolution.

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