HIERACIO TRANSSILVANICI-PICEETUM PAWL. ET BR.-BL. 1939 *CALAMAGROSTIETOSUM VILLOSAE* COLDEA ET AL. 2015 IN THE ORĂŞTIE RIVER BASIN (CENTRAL-WESTERN ROMANIA)

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Abstract. In the current paper we are presenting a phytosociological study of the spruce forests identified in the upper part of the Orăştie river basin situated in the central-western part of Romania, which belong to the association ***Hieracio transsilvanici-Piceetum*** and the subassociation ***calamagrostietosum villosae*** [7].

The characterization of the subassociation under analysis and the presentation of its synthetic table have been done by selecting the most representative releves carried out in the spruce forests on the upper course of the river Orăştie. The phytocoenoses of the subassociation were analyzed in terms of physiognomy and floristic composition, life forms, floristic elements and ecological indices.

The subassociation's phytocoenoses, which colonize the steep mountain slopes in the high boreal floor, fulfill hydrological, climatic and soil protection functions as well. We also notice the presence of Romanian Carpathian endemites (*Silene nutans* subsp. *dubia*) and Tertiary relicts (*Sanicula europaea*).

Keywords: phytocoenosis; association; relevee; floristic elements; life forms; ecological indices; *Picea abies*.

INTRODUCTION

The river basin of the Orăştie River occupies a South-Western position within the territory of Romania (Fig. 1). From the point of view of localization, the basin of the Orăştie River is situated between the Strei Valley (south and west) and the Cugir Valley in the east. To the north, the Orăştie river basin closes in the Mureş riverbed [23, 25].

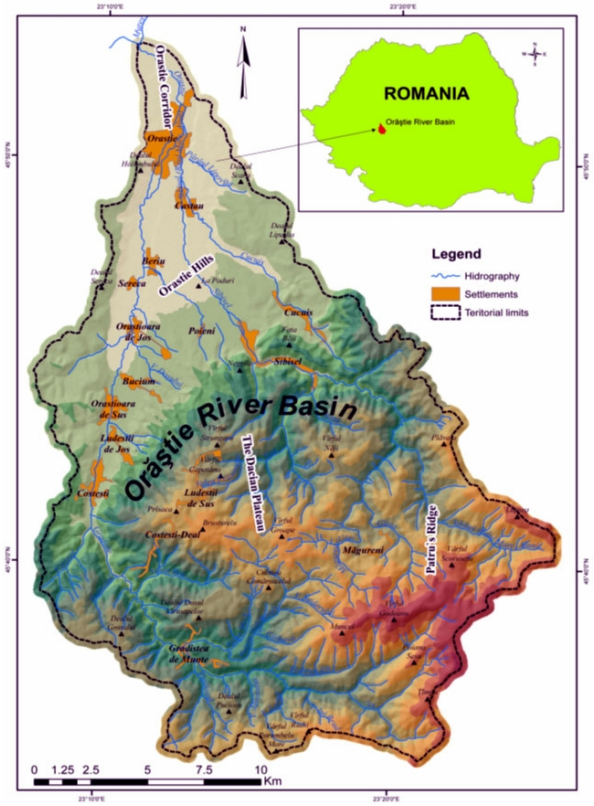

Figure 1. The location of the Orăştie river basin in Romania [27] (modified)

The Şureanu Mountains consist mainly of mesometamorphic and epimetamorphic crystalline schists, and some sedimentary rocks (sandstone, conglomerate, limestone, etc.) are added to the outskirts of the mountains [23]. We mention that only the western-north-western part of these mountains, a territory known as the Orăştie Mountains or the Sarmizegetusa Mountains [23], is included within the studied territory. The analyzed area is part of the temperate continental climatic zone, the climatic sector with oceanic influences, the climatic background of the Southern Carpathians, the complex topoclimate of the Parâng Mountains and the Orăştie lowlands [23].

Figure 2. *Hieracio transsilvanici-Piceetum calamagrostietosum villosae* (Valea Sibişelului - Măgureni, 15.09.2013)

The average thermal differences between the periphery of the massif and the mountain peaks are approximately 10ºC. At the northwestern edge of the massif, due to the warm air penetrations from the Banat-Crişana Plains, the mean temperatures vary between 9 and 10ºC [23]. In the winter season, the mean temperatures vary between -2°C and -7°C, in the spring temperatures are higher with 6-12°C, in summer the mean temperatures reach 8°C on high peaks and above 19°C at the foot of the mountains, and in autumn the mean temperatures are lower with 5.5°C - 7°C

compared to the summer months [23]. The atmospheric precipitations have multiannual average values of about 550-600 mm in peripheral areas, and over 1000 mm in central areas with higher altitudes [23]. In Transylvania the average amount of precipitation is 500 - 700 mm / year [14].

MATERIALS AND METHODS

The vegetation studies in the Orăştie river basin (south-western Romania) were carried out between 2009 and 2014 and attemped to encompass all of the habitats featuring the phytocoenoses of the ***Hieracio transsilvanici-Piceetum calamagrostietosum villosae*** association.

The vegetation research deployed the phytocoenologic survey methods drawn up by Braun-Blanquet (1964), adjusted to the particularities of the region under scrutiny [3]. The sampling techniques and the annotations (quantitative appraisals) were observed strictly in accordance with the instructions of the authors Borza et Boşcaiu (1965), while the identification of associations was done by means of the recognizable or characteristic species, without ever neglecting the dominant and differential species [2, 10].

The phytosociological worksheets contain information on the stational habitat conditions in which phytocoenoses develop: rock, soil, altitude, slope exposition, slope degree, vegetation coverage. Simultaneously with the marking of the taxonomy of the releves, the quantitative assessment of the participation of each species in the abundance-dominance on the Braun-Blanquet et Pavillard scale (1928) was made, and the general vegetation coverage was taken down by adding the average abundance and the percentage coverage corresponding to each figure in the scale according to the methods proposed by Tüxen (1955) and Ellenberg (1974), renowned authors of phytocoenology [4, 12, 24].

The phytocoenological table of the association was structured according to the methodology proposed by Braun-Blanquet (1964) and developed by Ellenberg (1974). For enlisting the subassociation in the superior coeno-taxonomic units, association, suballiance, alliance, order, class, and their nomenclature as well, the works of Coldea et. al (2015), *Les associations végétales de Roumanie*, Tome 3 [7] were taken into consideration.

The phytocoenological table of the association (Table 1) contains information on the floristic and coenologic composition of the plant populations that make up the phytocoenosis, the life form, the floristic element (phytogeographic), the ecological indices of humidity (U), temperature (T), soil reaction (R), the sequence number of the releves, the altitude (a.s.l), the sampled surface (m^2). The last column of the association table lists the constancy of species (K) marked by Roman numerals from I to V. The values of constancy (K) were calculated according to the methodology proposed by Braun-Blanquet et Pavillard (1928) and Cristea et al. (2004) [4,10].

The taxonomic identification followed the criteria established by the most recent literature [6, 20, 21]. The plant association was analyzed according to the main ecological indices of the component species, biological forms and floristic elements, the data being graphically presented by spectra and diagrams [11, 17].

RESULTS

The floristic inventory of the subassociation includes 47 species of cormophytes and two species of bryophytes. The tree layer is dominated by the characteristic species, *Picea abies*, which achieves an overall coverage of 82.5%, alongside *Abies alba*, *Sorbus aucuparia*, *Larix decidua* subsp. *carpatica*, *Fagus sylvatica* subsp. *sylvatica*, *Acer pseudoplatanus*, *Ulmus glabra*. The consistency of the tree layer is between 0.7 and 0.9, the trunk diameters are between 34 cm and 48 cm and the height of the trees reaches 28 m - 33 m. In the shrub layer there are isolated specimens of *Sambucus racemosa* and *Rubus idaeus.*

The herbaceous layer (with a 50% to 55% coverage) is dominated by the differential species for the subassociation, *Calamagrostis villosa*, which achieves a general coverage of 21.5%, along with the species characteristic of the ***Soldanello majori-Piceenion*** Coldea 1991 suballiance, the ***Piceion excelsae*** Pawl. in Pawl. et al. 1928 alliance, the ***Piceetalia excelsae*** Pawl. in Pawl. et al. 1928 order, and the ***Vaccinio-Piceetea*** Br.-Bl. in Br.-Bl. 1939 class: *Luzula sylvatica, Homogyne alpina, Prenanthes purpurea, Circaea alpina*, *Luzula luzuloides* subsp. *luzuloides, Oxalis acetosella, Gymnocarpium dryopteris, Campanula abietina, Huperzia selago, Lycopodium annotinum. Melampyrum sylvaticum*. The subassociation includes transgressive plants of the ***Carpino-Fagetea*** Jakucs ex Passarge 1968 and ***Epilobietea angustifolii*** Tüxen et Preising (in Tüxen 1950) classes: *Athyrium filix-femina,, Festuca drymeja, Carex brizoides, Circaea lutetiana, Galeobdolon luteum, Galium odoratum, Geranium robertianum, Galeopsis speciosa, Senecio germanicus* (Table 1).

The life forms spectrum (Fig. 3) indicates the prevalence of hemicryptophytes (H=46.80%), followed by phanerophytes (Ph=21.26%, of which: Mph=11.42%, mPh = 5.71%, nPh = 3.80%), geophytes (G=14.89%), terophytes (Th + TH = 10.63%) and camephytes (Ch = 6.38%).

In the spectrum of the floristic elements (Fig. 4), the largest percentage is held by the Eurasian species (29,78%), followed by the circumpolar (21,27%), European (19,14%) and Central European (12, 76%).

The diagram of the ecological indices (Fig. 5) shows that the mesophilous species ($U_{3-3.5}$ = 61.69%), prevail and then comes the meso-hygrophilous ($U_{4-4.5}$ = 19.14%), hygrophilous ($U_{5-5.5}$ = 6,38%), xero-mesophilous ($U_{2-2.5}$ = 8.50%) and amphitolerant species (U_0 = 4.25%). If analyzed in terms of temperature, the micro-mezothermophilous ($T_{3-3.5}$ = 42.54%) are

predominant, followed by microthermophilous ($T_{2-2.5}$ = 40.41%) and eurithermophilous (T_0 = 17,02%). As to the chemical reaction of soils, it indulges the development of acido-neutrophilous plant species (R_3 = 27.65%), acidophilous (R_2 = 21.27%), weakly acid-neutrophilous (R_4 = 12.76%), strongly acidophilous (R_1 = 6.37%) and amphitolerant species (R_0 = 31.91%).

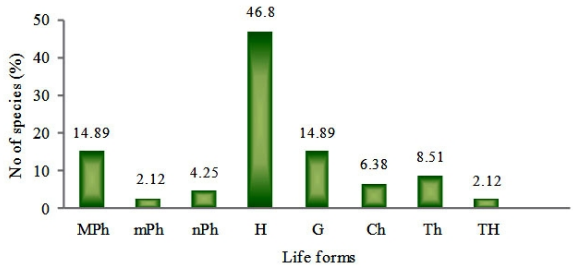

Figure 3. Life forms spectrum of the association *Hieracio transsilvanici-Piceetum calamagrostietosum villosae*, where: MPh - Megaphanerophytes; mPh - Mezophanerophytes; nPh - Nanophanerophytes; H - Hemicryptophytes; G - Geophytes; Ch- Chamaephytes; Th - Annual terophytes; TH – Biennial terophytes.

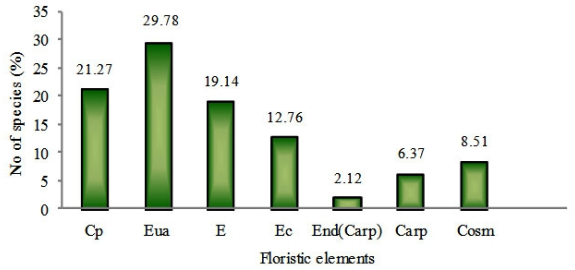

Figure 4. Spectrum of floristic elements of the association *Hieracio transsilvanici-Piceetum calamagrostietosum villosae*, where: Cp - Circumpolar; Eua - Eurasian; E - European; Ec - Central European; End-Carp - Carpathian endemism; Carp - Carpathian; Cosm – Cosmopolitan.

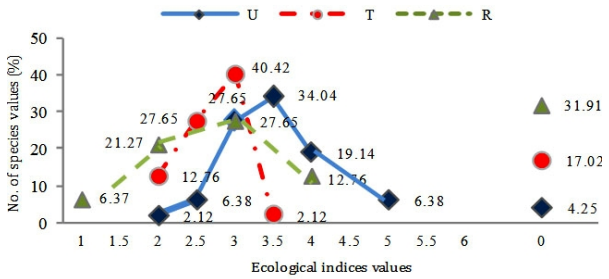

Figure 5. Diagram of ecological indices for the association *Hieracio transsilvanici-Piceetum calamagrostietosum villosae*, where: U - humidity, T - temperature, R - the chemical reaction of the soil.

DISCUSSIONS

The phytocoenoses of the subassociation analyzed by us develop at altitudes of 1150 m - 1400 m, on slopes with eastern, western, northern and southwestern exposure, with an inclination of 10^o - 27^o (Table 1).

The analysis of phytocoenoses through the life forms spectrum (Fig. 3) shows that they are dominated by hemicryptophytes, their abundance being influenced by the moderate temperate climate, followed by fanerophytes as basic constituents of forests.

The floristic elements spectrum (Fig. 4) highlights the prevalence of the Eurasian species in the phytocoenoses of the subassociation, whose genesis stemmed from the current continental expanses of Europe and Asia, followed by Circumpolar plants, whose development is favoured by the relatively low temperatures in this habitat.

On analysing the diagram of ecological indices, it turns out that the phytocoenoses have a mesophilous character towards meso-hygrophilous, micro-mesothermophilous, weak acido-neutrophilous towards acidophilous, a high percentage of the species being euri-ionic.

Picea abies forests with *Hieracium transsylvanicum* are largely represented in the Romanian Carpathians, and are described in terms of phytocoenology by the more recent literature [5, 7, 18].

Since the species *Calamagrostis villosa* from the association *Hieracio transsilvanici – Piceetum* in the Orăștie river basin accounts for 21.5% general coverage, we have chosen it (*Calamagrostis villosa*) as the differential species for the ***calamagrostietosum villosae*** subassociation.

The floristic composition of the above mentioned subassociation is described by Coldea et al. (2015) in as many as 38 phytocoenological releves across the Romanian Carpathians at high altitudes between 1000 to 1650 metres a.s.l. [1, 7, 8, 9, 19, 22].

This floristic composition, as it occurs in the Orăştie river basin (Southern Carpathians), highlights the dominance of the species belonging in the ***Vaccinio-Piceetea*** class, with a number of species transgressing from the ***Carpino-Fagetea*** class.

If we are to compare the phytocoenoses described by Coldea et al. (2015) to those of the Orăștie river basin (Southern Carpathians), several differences and also similarities can be noticed, making room for our commentaries below.

The layer of trees is dominated by the prevalent species *Picea abies*, along with *Abies alba*, *Fagus sylvatica* subsp. *sylvatica* and *Acer pseudoplatanus*, and in the undergrowth layer, the species *Sorbus aucuparia* and *Sambucus racemosa*, *Rubus idaeus*, *Vaccinium myrtillus* can be found [26].

The well-represented herbaceous layer consists of the species: *Athyrium filix-femina*, *Calamagrostis villosa*, *Campanula abietina*, *Galium odoratum*, *Hieracium transsylvanicum*, *Homogyne alpina*, *Huperzia selago*, *Luzula luzuloides*, *Luzula sylvatica*, *Lycopodium annotinum*, *Melampyrum sylvaticum*, *Oxalis acetosella*, *Prenanthes purpurea*, *Sanicula europaea* [26].

In the phytocoenoses analyzed by Coldea et al (2015) there are species we have not identified in the Orăștie river basin (Southern Carpathian), such as: *Clematis alpina*, *Doronicum austriacum*, *Melampyrum saxosum*, *Pinus mugo*, *Ranunculus carpaticus*, *Ribes petraeum*, *Soldanella major* ș.a. [7]. We consider that

these species are not found in the territory analyzed by us due to the lower altitudes at which the ***calamagrostietosum villosae*** subassociation's phytocoenoses (1150 - 1400 metres a.s.l.) are present.

We consider that the spruce forests in the Orăştie river basin are important from the point of view of protecting the environment, of preserving its biodiversity [16]. Within these forests there are several conservation targets:

- sheltering endangered plant species (*Abies alba*) [13], Romanian Carpathian endemites (*Silene nutans* subsp. *dubia*) [6, 20, 28], Tertiary relicts (*Sanicula europaea*) [6, 20];
- ensuring that the water quality, and even quantity, are maintained;
- providing wood products and other accessories for local communities;
- since they are located on steep slopes (10-27º), their management must permanently maintain the forest canopy in a sufficient coverage to fulfill the role of soil protection against erosion, landslides or avalanches [15].

Table 1. Association ***Hieracio transsilvanici-Piceetum*** Pawl. et Br.-Bl. 1939 ***calamagrostietosum villosae*** Coldea et al. 2015 in Orăştie River Basin

L.f.	**F.e.**	**U.**	**T.**	**R.**	**No. of relevé**	**1**	**2**	**3**	**4**	**5**	**K**
					Altitude (a.s.l.)	1150	1200	1250	1350	1400	
					Exposition	E	V	N	SV	SV	
					Slope (degree) (˚)	27	24	10	20	26	
					Hight of the trees (m)	30	29	33	28	28	
					Trunk diam. (cm)	48	43	42	48	34	
					Consistency of tree layer (%)	0.7	0.9	0.9	0.9	0.9	
					Herbaceous layer cover (%)	50	50	55	50	50	
					Surface (m^2)	1000	1000	1000	1000	1000	
0	1	2	3	4	5	6	7	8	9	10	11
					Car. ass.						
MPh	E	0	0	0	*Picea abies*	4	5	5	5	5	V
H	Carp-B	3	0	0	*Hieracium transsylvanicum*	.	.	+	+	+	III
					Differential for subassociation						
H	Eua	4	2,5	1,5	*Calamagrostis villosa*	2	2	3	2	2	V
					Soldanello majori-Piceenion* et *Piceion excelsae						
MPh	Ec	4	3	0	*Abies alba*	+	+	+	+	.	IV
H	Ec	3,5	2,5	2	*Luzula sylvatica*	+	+	+	.	.	III
H	E(Alp)	3,5	2,5	2,5	*Homogyne alpina*	.	.	+	+	.	II
H	Ec(Mont)	3	2,5	0	*Prenanthes purpurea*	.	.	.	+	+	II
G	Cp	4	2,5	3	*Circaea alpina*	.	+	.	.	.	I
					Piceetalia excelsae* et *Vaccinio-Piceetea						
H	E	2,5	2,5	2	*Luzula luzuloides* subsp. *luzuloides*	1	+	+	+	+	V
H-G	Cp	4	3	3	*Oxalis acetosella*	+	1	1	+	+	V
Ch(nPh)	Cp	0	2	1	*Vaccinium myrtillus*	+	+	1	.	+	IV
G	Cp	3	2,5	2	*Gymnocarpium dryopteris*	.	+	+	1	.	III
TH	Carp-B	3,5	2	2	*Campanula abietina*	.	+	.	.	+	II
Ch	Cosm	3,5	2	2	*Huperzia selago*	.	.	+	+	.	II
MPh-mPh	E	3	2,5	2	*Sorbus aucuparia*	.	.	.	+	+	II
Ch	Cp	4	2,5	2	*Lycopodium annotinum*	.	.	+	+	.	II
Th	Eua (Mont)	3	0	1,5	*Melampyrum sylvaticum*	.	.	+	.	+	II
MPh	Carp-Sudet	2,5	0	0	*Larix decidua* subsp. *carpatica*	.	.	.	.	+	I
					Carpino-Fagetea						
H	Cosm	4	2,5	0	*Athyrium filix-femina*	1	1	1	2	2	V
MPh(mPh)	E	3,5	3	0	*Fagus sylvatica* subsp. *sylvatica*	1	+	+	+	+	V
nPh	Eua	3	2,5	3	*Rubus hirtus*	+	+	+	1	1	V
G-H	E-M	4	2	3	*Festuca drymeja*	+	+	.	.	+	III
MPh	Ec	3,5	3	3	*Acer pseudoplatanus*	+	.	.	+	.	II
G	Eua(M)	3,5	3	4	*Circaea lutetiana*	.	.	.	+	+	II
H-Ch	Ec	3	0	4	*Galeobdolon luteum*	.	+	.	+	.	II
G	Eua	3	3	3	*Galium odoratum*	.	+	.	.	+	II
Th-TH	Cosm	3,5	3	3	*Geranium robertianum*	+	.	.	.	+	II
H	Cp	3	3	0	*Poa nemoralis*	.	.	+	+	.	II
H	E	3,5	3,5	3,5	*Polystichum aculeatum*	.	+	.	+	.	II
MPh(mPh)	Eua	4	3	3	*Ulmus glabra*	.	.	.	+	+	II
G	Ec	3,5	3	2	*Carex brizoides*	.	.	+	.	.	I
H(Hh)	Cp	3,5	3	4	*Carex sylvatica*	.	+	.	.	.	I
Th	Eua	4	3	4	*Impatiens noli-tangere*	.	.	.	.	+	I
H	E	3,5	3	3	*Myosotis sylvatica*	.	.	.	.	+	I
G	Eua	3	2,5	2,5	*Polygonatum verticillatum*	.	.	+	.	.	I
H	Eua	3,5	3	4	*Sanicula europaea*	.	.	.	.	+	I

H	Eua	3,5	0	0	*Stachys sylvatica*	.	.	.	.	+	I
					Epilobietea angustifolii						
Th	Eua	3	2	0	*Galeopsis speciosa*	.	.	+	.	+	II
nPh	Cp	3	3	3	*Rubus idaeus*	.	+	.	.	+	II
mPh	Cp	3	2	3	*Sambucus racemosa*	.	+	.	.	+	II
H	Eua	3,5	3	3	*Senecio germanicus*	.	+	.	.	+	II
					Variae syntaxa						
H	Cosm	3,5	0	0	*Cystopteris fragilis*	.	.	+	+	.	II
H	Eua(M)	5	0	0	*Cardamine amara*	.	.	.	.	+	I
H	Cp(Bor)	5	3	0	*Cardamine pratensis*	.	.	.	.	+	I
H-Hh	Eua	5	3	0	*Myosotis scorpioides*	.	.	.	.	+	I
H	End(Carp)	2	3	0	*Silene nutans* subsp. *dubia*	.	.	.	.	+	I
H	E	2,5	2,5	4	*Thalictrum aquilegiifolium*	.	.	.	.	+	I
-	-	-	-	-	*Polytrichum commune*	2	2	.	.	.	II
-	-	-	-	-	*Rhytidiadelphus triquetrus*	.	.	+	.	.	I

where: L.f. - life forms; MPh - Megaphanerophytes; mPh - Mezophanerophytes; nPh - Nanophanerophytes; Ch - Chamaephytes; H - Hemicryptophytes; G - Geophytes; Th - Annual therophytes; TH – Biennial terophytes.

F.e. - floristic elements: Carp-B – Carpathian-Balkan; Carp-Sudet - Carpathian-Sudet; Cosm - Cosmopolitan; Cp - Circumpolar; Cp(Bor) - Circumpolar -Boreal; E – European; E(Alp) – European-Alpine; E-M – European-Mediterranean; E(Mont) – European-Montain; Ec - Central European; Ec(Mont) – Central European-Montain; End-Carp - Carpathian Endemism; Eua - Eurasian; Eua(M) – Eurasian- Mediterranean; Eua(Mont) – Eurasian-Montain;

Ecological indices: U - humidity, T - temperature, R - the chemical reaction of the soil; the range of values between 1 and 6 [26]. Synthetic phytosociological indices: K – constancy.

Place and date of mapping: 1 -2, Dealul de Groapă, 15.09.2013, 14.06.2014; 3 - 4, Măgureni, 15.09.2013, 14.06.2014; 5, Gliva, 15.09.2013, 14.06.2014.

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