PHYTOCENOSIS OF THE *JUNIPERO-BRUCKENTHALIETUM* PLANT ASSOCIATION WITH *BRUCKENTHALIA SPICULIFOLIA*, *JUNIPERUS SIBIRICA* AND *VACCINIAS BIULINIUM* AS ARCTIC-ALPINE, CIRCUMPOLAR, CARPATO-BALKAN DOMINANT SPECIES IN THE WESTERN CARPATHIANS – BIHARIA MASSIF

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Abstract

The phytocenoses of the Junipero-Bruckenthalietum association develop in forest sites with mountain relief consisting of high peaks, peaks and moderate to steep slopes ranging between 8º and 25º, exposed to sun, and strong and cold winds. The lithological substrate consists of siliceous rocks on which grow various soils such as humus soils and lithosols which are depleted of humus, rich in skeleton, with stone blocks on their surface, called rankers.

The floristic index of the plant association totals a number of 44 species, which shows a high biodiversity, considering the relief and the pedo-climatic conditions with impact on vegetation.

The phytocenoses of the Junipero-Bruckenthalietum association are dominated by hemicryptophyte species (65.90%), followed by phanerophyte ones (11.35%), and with regard the geographical area of the association, Eurasian species predominate (25%), followed by circumpolar ones (22.72%); endemic species share equals the Central European ones (i.e. 13.63%). With regard the ecological factors, in terms of soil moisture mesophilic species are dominant (40.90%), considering temperature, microthermal species predominate (56.81%) while regarding the chemical reaction of the soil, euriionic species are ranked first (25%). The karyotype spectrum shows that polyploids are dominant (59.09%), followed by diploids (34.09%). These meadows have a high ecological value because they host eight (8) rare, endemic, endangered species, enclosed in the Red lists.

The study of this association found in the surveyed territory, together with the analysis of bioforms, floristic elements, ecological indices, and along with the economic analysis and interpretation of cytogenetic characteristics, provides important information on habitat conditions, the economic, ecological and scientific importance of phytotaxa found.

Key words: phytocenoses, bioforms, floristic elements, ecological indices, karyotype

INTRODUCTION

In this paper, on the study of common juniper brushwood with alpine heath within the Biharia Massif, in addition to traditional phytocenological scientific information of the Central European School, flora inventory, the analysis of spectrum of bioforms, phytogeographic elements, diagram of ecological indices and genetic karyotypes, we aim at broadening the scope and interdisciplinary approach, the assessment of the

scientific value, and the sustainable management of the phytocenoses of the association, and of the protection and conservation measures for the species concerned. This association brings together subshrub and tree brush grown into the natural habitat of Community interest; Southeastern Carpathians spike heath (*Bruckenthalia spiculifolia*) and common juniper (*Juniperus sibirica*), code, R3107. Correspondence: Natura 2000: 4060 Alpine and Boreal heaths; EMERALD: 31.46 *Bruckenthalia* heaths; PAL.HAB: 31.4632 Carpathian *Bruckenthalia* heaths; EUNIS: F2.2632 Carpathian *Bruckenthalia* heaths (Doniță et al. 2005).

The aim of this research is to develop a floristic, phytocenological, ecological, cytogenetic, economic, syndynamic and eco-productive study of shrublet having *Bruckenthalia spiculifolia* and *Juniperus communis* ssp. *Alpina* as dominant species.

MATERIAL AND METHOD

We carried out our research in Western Carpathians (Apuseni Mountains) - the Biharia Massif. The biological material we were interested in consists of Southeastern Carpathians spike heath (*Bruckenthalia spiculifolia*) and common juniper (*Juniperus sibirica*) shrubs, which sporadically widespread in forests sites with mountain relief (altitudes ranging between 1,674 m and 1,832 m), consisting of high peaks, peaks and moderate to steep slopes ranging between 8º and 25º, exposed to sun, and strong and cold winds. The lithological substrate consists of siliceous rocks on which grow various soils such as humus soils and lithosols which are depleted of humus, rich in skeleton, with stone blocks on their surface, called rankers.

We carried out seven (7) phytocenological surveys in the most representative phytocenoses. In the association table (see Table 1) we enclosed all the species found by us, and classified in the corresponding coeno-taxonomic units (i.e. subaliance, alliance, order, classes), consistent with the constant (K), and according to the indications of the renowned authors (Borza et Boşcaiu, 1965), (Cristea et al., 2004), while observing the criteria of the ecological and floristic systems elaborated by Tüxen (Tüxen, 1955), and Braun-Blanquet (Braun-Blanquet, 1964), and based on the information of some more recently published works belonging to the various authors (Coldea et al., 1997), (Oberdorfer, 1992), (Borhidi, 2003), (Sanda et al., 2008), (Chifu et al., 2014). The quantitative criterion we followed in the research of phytocenosis is the abundance and dominance of species, according to the system developed by Braun-Blanquet (Braun-Blanquet et Pavillard, 1928), with the establishment of constancy classes (K = I-V). The phytocenosis of the *Junipero-Bruckenthalietum* association was analysed, and characterized ecologically, phytocenologically cytogenetically

based on the association table (see Table 1) and the histograms with reference to the distribution of bioforms, floristic elements, ecological indices and genetic karyotypes.

We identified and described the association 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).

The information on the value of ecological indices, bioforms, floristic elements are presented according to works elaborated by various (Sanda et al, 2003), (Meusel et Jäger, 1992), (Cristea et al., 2004), (Burescu et Toma, 2005). Data on species' karyotype was taken over from dedicated literature too (Majovsky et Murin, 1987), (Sanda et al., 2003), (Ciocârlan, 2009), (Moore, 2009).

In order to appreciate the economic value of plants studied, we used the information from the publication "Flora României" (1952-1976) (*Romania's Flora – 1952-1976*), as well as data from another paper (Ciocârlan, 2009), to which we added our observations and findings regarding the use of plants by the locals.

To determine the status of rare, vulnerable, endangered, endemic species we used the "Red Lists" prepared by various authors (Boșcaiu et al., 1994), (Oltean et al., 1994), (Dihoru et Negrean, 2009), and the European Red Lists of Vascular Plants (Bilz et al., 2011).

RESULTS AND DISCUSSION

This association was reported in Romania, namely in the following locations: Sebeș Valley by Borza (1959); in Țarcu, Godeanu, and Cerna Mountains by Boșcaiu (1971); in the Iezer-Păpușa Mountains by Alexiu (1998); and in Retezat Mountains by Coldea (1993). We found this association in the middle third of the mountain slope between the mountain peaks Cucurbăta Mare and Cucurbăta Mică, on Cucurbăta Mare Peak and Bisericuța Hill, all belonging to the Biharia Massif in the Western Carpathians (Apuseni Mountains).

The floristic inventory (see Table 1) of these shrublet and brushwood encompasses 44 species, which represents a high biodiversity in this area taking into account the pedoclimatic and relief conditions. The characteristic and dominant species of the association is *Juniperus communis* ssp. *Alpina* with a coverage of 83.92%, ADm and maximum value of constant (K = V) while the differential and characteristic species for the association *Bruckenthalia spiculifolia* achieves a low coverage of only 0.42%, ADm, but a maximum value of constant (K = V).

Table 1

Junipero – Bruckenthalietum Horvat, 1936

Bioform	Fl. element	M	T	R	G	Survey no.	1	2	3	4	5	6	7	K	ADm
						Altitude AMSL	1832	1817	1816	1780	1775	1748	1674		
						Exposure	SV	V	V	SV	SV	V	S		
						Slope (^{0})	18	12	14	8	20	25	13		
						Vegetation cover (%)	90	90	90	100	100	100	100		
						Surveyed area (m^2)	400	400	400	400	800	800	400		
						Car. ass.									
mPh	Cp-A-a	2.5	1.5	4	D	*Juniperus communis* ssp. *alpina*	5	5	5	5	5	5	4	V	83.92
nPh	Carp-B	2.5	2.5	1.5	P	*Bruckenthalia spiculifolia*	+	+	.	+	+	+	+	V	0.42
						Junipero- Bruckenthalion									
Ch-nPh	Cp	0	2	1	D	*Vaccinium myrtillus*	2	3	3	3	3	4	1	V	33.57
Ch-nPh	Cp-Bo	3	2	1	D	*Vaccinium vitis- idaea*	+	+	1	1	+	+	.	V	1.71
H	Ec	0	0	0	D	*Laserpitium krapfii*	+	+	+	+	+	+	+	V	0.50
H	End	0	2.5	0	D	*Campanula serrata*	+	.	+	+	+	+	+	V	0.42
TH	Carp-B	3.5	2	2	P	*Campanula abietina*	+	.	.	.	.	.	+	II	0.14
						Junipero- Pinetalia mugi									
H	E	3.5	2.5	2.5	P	*Homogyne alpina*	.	+	+	+	+	+	.	IV	0.35
H	Eua	4	2.5	1.5	P	*Calamagrostis villosa*	.	.	.	.	+	+	.	II	0.14
H	Ec	3.5	2.5	0	P	*Knautia dipsacifolia*	.	+	.	.	.	.	.	I	0.07
H	Eua-A-a	3.5	2	4	P	*Hieracium aurantiacum*	.	.	.	.	.	.	+	I	0.07
						Vaccinio - Piceetea									
H	Cp	0	0	1	P	*Deschampsia flexuosa*	1	+	+	+	+	+	.	V	1.71
MPh	E	0	0	0	D	*Picea abies*	+	+	+	+	+	+	+	V	0.5
G	Eua	4	2.5	4	DP	*Veratrum album*	.	+	.	.	.	+	.	II	0.14
Ch-nPh	Cp-Bo	0	0	1	P	*Vaccinium gaultherioides*	.	.	.	+	.	.	.	I	0.07
H-G	Cp-Bo	3	2	2.5	D	*Moneses uniflora*	.	.	.	.	.	.	+	I	0.07
G	End	3.5	2	4	P	*Ranunculus carpaticus*	.	.	.	.	.	.	+	I	0.07
H	Eua	4	3	3	D	*Hypericum maculatum*	+	+	+	+	+	.	+	V	0.42
Ch	End	2.5	2	4	P	*Thymus bihoriensis*	+	+	.	.	+	+	+	IV	0.35
H	Eua-Cp	0	0	1.5	D	*Nardus stricta*	1	2	.	.	3	.	.	III	8.57
H	End	2.5	2	0	P	*Campanula rotundifolia ssp.polymorpha*	+	+	.	.	+	.	.	III	0.21

Table 1 (continuation)

Biof.	Fl. element	M	T	R	G	Survey no	1	2	3	4	5	6	7	K	ADm
H	Alp-Carp-B	2.5	3	4	P	*Achilea distans*	.	+	+	.	.	+	+	III	0.28
G	Alp-Carp-B	2	0	4	D	*Scorzonera rosea*	.	.	+	+	+	.	+	III	0.28
H	E	3	2.5	3	P	*Arnica montana*	.	.	+	+	.	.	.	II	0.14
H-Ch	Eua	2	1	3	P	*Antennaria dioica*	.	.	.	+	.	.	+	II	0.14
H	Eua	0	0	0	P	*Potentilla erecta*	.	.	.	+	+	.	.	II	0.14
H	Eua	0	2	2	P	*Luzula sudetica*	.	.	.	.	+	.	.	I	0.07
Th-TH	Ec	2.5	2.5	4	P	*Gentianella amarella*	.	.	.	.	.	.	+	I	0.07
H	Cp	3	3	3	P	*Gnaphalium sylvaticum*	.	.	.	.	.	.	+	I	0.07
H	End	3.5	2	2	DP	*Viola declinata*	.	.	.	.	.	.	+	I	0.07
						Querco – Fagetea									
H	Carp- B	3	2	2.5	P	*Senecio papposus*	.	+	.	.	.	.	.	I	0.07
H	Cosm	4	2.5	0	P	*Athyrium filix- femina*	.	.	.	.	.	+	.	I	0.07
H-Ch	Ec	3	0	4	D	*Lamium galeobdolon*	.	.	.	.	.	+	.	I	0.07
H	Eua	3	2.5	0	D	*Fragaria vesca*	.	.	.	.	.	.	+	I	0.07
H	End	4	2	3	D	*Leucanthemum waldsteinii*	.	.	.	.	.	.	+	I	0.07
						Molinio- Arrhenatheretea									
H	Cp	3	0	3	P	*Luzula campestris*	+	.	+	+	+	+	+	V	0.42
H	Eua	4	3	0	P	*Molinia caerulea*	.	+	.	.	.	.	+	II	0.14
H	E	3	2	0	P	*Alchemilla vulgaris*	.	.	.	.	.	.	+	I	0.07
						Epilobietea angustifolii									
nPh	Cp	3	3	3	DP	*Rubus idaeus*	+	+	.	.	.	+	+	III	0.28
mPh	Carp-B-Sudet	4	2	2	D	*Salix silesiaca*	.	.	.	+	.	.	.	I	0.07
						Betulo- Adenostyletea									
H	Ec	4	2	4	P	*Gentiana asclepiadea*	.	.	+	.	.	.	.	I	0.07
H	Eua	3.5	3	3	P	*Senecio nemorensis ssp.jacquinianus*	.	.	.	.	.	+	.	I	0.07
						Varia syntaxa									
H	Cp	4	1.5	0	P	*Epilobium anagallidifolium*	.	+	.	+	.	.	.	II	0.14
TH	Ec	3	0	3	D	*Silene italica ssp. nemoralis*	.	.	.	.	.	.	+	I	0.07

Place and date of surveys: 1 - 3 Cucurbăta Mare peak (03.08.2018); 4 - 6 The middle third of the slope between Cucurbăta Mare and Cucurbăta Mică peaks (03.08.2018, 05.08.2018); 7 - Bisericuţa Hill (04.08.2018).

Along with the two characteristic species of the association, there are present other species belonging to the basic coenotaxa of the association, namely the ***Junipero-Bruckenthalion*** (*Vaccinium myrtillus, Vaccinium vitis-idaea, Laserpitium krapfii, Campanula serrata, Campanula abietina*), order JUNIPERO-PINETALIA MUGI (*Homogyne alpina, Calamagrostis villosa, Knautia dipsacifolia, Hieracium aurantiacum*), class **VACCINIO-PICEETEA** (*Deschampsia flexuosa, Picea abies, Veratrum album, Vaccinium uliginosum* ssp. *microphyllum, Moneses uniflora, Ranunculus carpaticus*), but also transgressive species belonging to the following classes: **NARDO-CALLUNETEA** (*Hypericum maculatum, Thymus bihoriensis, Nardus stricta, Campanula rotundifolia* ssp. *polymorpha, Achilea distans, Scorzonera rosea, Arnica montana, Antennaria dioica, Potentilla erecta*), **QUERCO-FAGETEA** (*Senecio papposus, Athirium filix-femina, Lamium galeobdolon, Fragaria vesca, Leucanthemum waldsteinii*), **MOLINIO-ARRHENATHERETEA** (*Luzula campestris, Molinia caerulea, Alchemilla vulgaris*), **EPILOBIETEA ANGUSTIFOLII** (*Rubus idaeus, Salix silesiaca*) and **BETULO-ADENOSTYLETEA** (*Gentiana asclepiadea, Senecio nemorensis* ssp. *jacquinianus*).

The bioforms (see Figure 1 below) of this association are dominated by hemicryprophytes (65.90%), followed at a great distance by phanerophytes (11.35%), cameophytes (9.09%) and geophytes, the latter having an equal share with terophytes (i.e. 6.81% each). Becoming familiar with the types of bioforms is important because it highlights the predominant orographic characteristics of the habitat exerted on plants by biotic and abiotic factors.

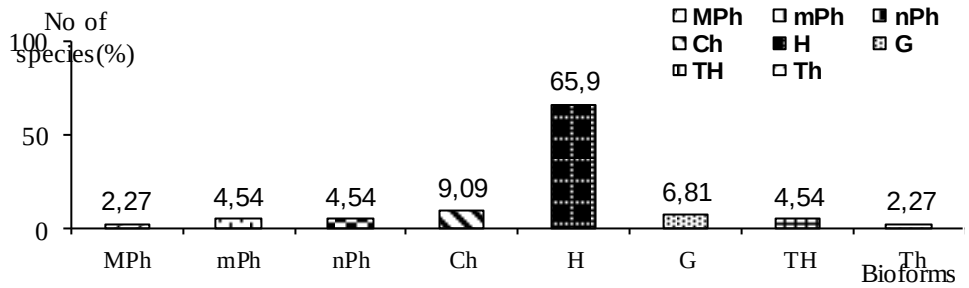

Fig. 1 Spectrum of the bioforms of the *Junipero-Bruckenthalietum* association
Legend: MPh = Megaphanerophytes; mPh = Mesophanerophytes; nPh = Nanophanerophytes; Ch = Chamaephytes; ; H = Hemicriptophytes; G = Geophytes; TH = Annual terophytes; Th = Biannual therophytes.

With regard the geographical area and the current distribution of the species (see Figure 2 below), the phytocenoses of the *Junipero-Bruckenthalietum* association are dominated by the Eurasian species (25%), followed closely by the circumpolar ones (22.72%), the Central-European and endemic (13.63% each), the European and Carpatho-Balkan species (9.09% each), the Alpine-Carpatho-Balkan (4.54%) and finally by the cosmopolitan species (1.27%). Knowing the shares of phytogeographic elements provides us with information on the richness and diversity of the gene pool, the geographical interferences triggered by the migration of plant species over time.

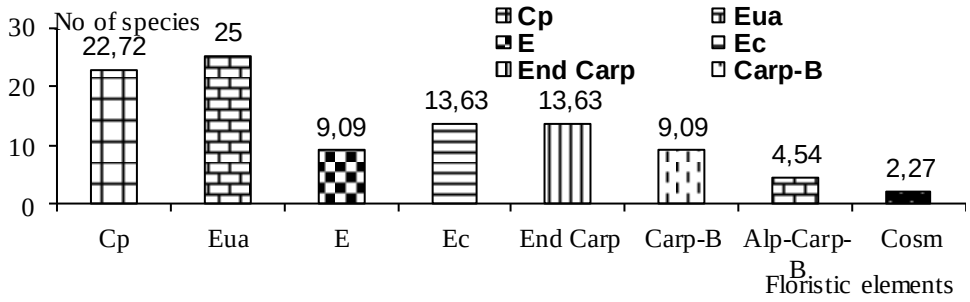

Fig.2 Spectrum of floristic elements from the *Junipero-Bruckenthalietum* association
Legend: Cp = Circumpolar; Eua = Eurasian; E = European; Ec = Central European; End Carp = Endemit-Carpathian; Carp-B = Carpathian-Balkan; Alp-Carp-B = Alpine-Carpathian-Balkan; Cosm = Cosmopolitan.

The analysis of ecoforms (see Figure 3) shows that, in terms of soil moisture, mesophilic species (40.90%) are dominant, followed by meso-hygrophiles in equal share with the eurihydrous species (20.45% each), the last being xero-mesophilic species (18.17%). With regard the temperature factor, the microthermal (56.81%), followed by the eurythermal (22.72%), micro-mesothermal (13.63%) and hekistothermal (6.81%) species are dominant. Finally, considering the chemical reaction of the soil, the euriionic species are dominant (25%), followed by the weakly acid-neutrophilic (22.72%), acid-neutrophilic (20.45%) species, while the acidophilic and strongly acidophilic species are ranked last (15.90% each).

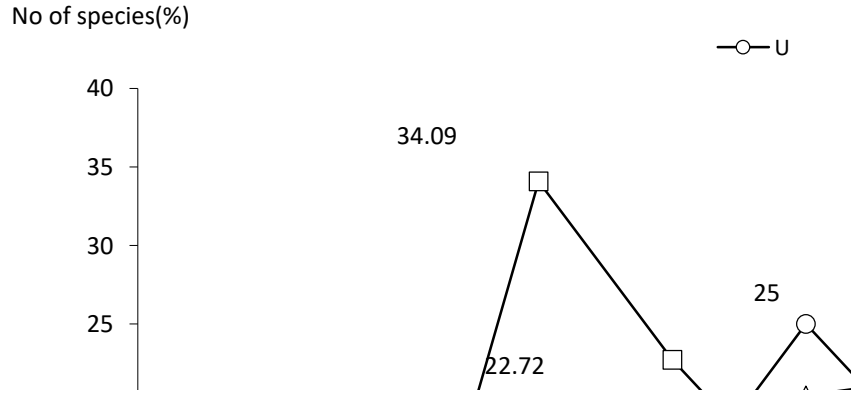

Fig.3 Diagram of ecological indices for the *Junipero-Bruckenthalietum* association

The karyotype spectrum (see Figure 4 below) shows high share of polyploid species (59.09%), as against diploid (34.09%) and diplo-polyploid (6.81%) species. The value of the diploid index is 0.57.

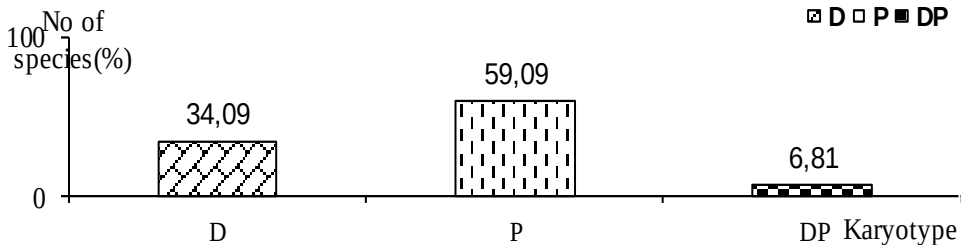

Fig. 4 The karyotype spectrum of the *Junipero-Bruckenthalietum* association
Legend: D = Diploids; P = Polypoids; DP = Diplo-polyploids

These phytocenoses enjoy a high conservative value, being rare communities in sparse habitats, and being included in and protected by the Emerald Network of Natural Protection Sites (Doniță et al., 2005). At the same time, these shrublet and brushwood are of high scientific importance since they host endemic species e.g. *Thymus bihoriensis, Campanula serrata, Campanula rorundifolia* ssp. *polymorpha, Ranunculus carpaticus, Viola declinata, Leucanthemum waldsteinii,* rare species e.g. *Scorzonera rosea, Gentianella, Micropella*, species with high economic value e.g. *Vaccinium myrtillus, Vaccinium vitis-idaea, Picea abies, Rubus idaeus*, but also decorative species marking the alpine and subalpine landscape e.g. *Campanula abietina, Athyrium filix-femina*.

CONCLUSIONS

1. The phytocenoses of these juniper bushes (*Juniperus communis ssp. Alpina*) with spike heath (*Bruckenthalia spiculifolia*) have a high conservative value, being rare plant communities in sparse habitats
2. With regard the spectrum of bioforms, hemicryotophytes are dominant (65.90%), followed at great distance by phanerophytes (11.35%), and cameophytes (9.09%).
3. Regarding the geographical area, the Eurasian species are dominant (25%), followed closely by the circumpolar ones (22.72%).
4. In terms of the ecological indices, with regard moisture the most numerous are the mesophilic species (40.90%), with regard temperature the dominant species are microthermal ones (56.81%), and with regard the chemical reaction of the soil the euriionic species are dominant (25%).
5. The analysis of chromosomal karyotypes highlights the dominance of polyploid species (59.09%), as against to diploid (34.09%) and diplo-polyploid (6.81%) ones.

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