ECOLOGY OF EUROPEAN BEECH STANDS POPULATED WITH *SYRINGA JOSIKAEA* IN THE WESTERN CARPATHIANS, ROMANIA

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Abstract

The European beech stands populated with Syringa josikaeagrowing in the Western Carpathians, Remeți Forest District, Management unit V Iadului Valley, compartments 66A, 70A, 74, 78B, and 82A were studied with regardthe ecology of plant populations subordinated to the association Pulmonario rubrae - Fagetum (Soó 1964) Täuber 1987 - syringetosum josikaeae L. Burescu 2018. The analysis of the ecological categories of European beechstands with Hungarian/Transylvanian lilac (Syringa josikaea), shows us that hemicriptophytes (52.54%), and phanerophytes (28.78%) are the dominant in terms of biological forms, the spectrum of phytogeographic elements include the dominance of Eurasian species (32.20%) accompanied by European species (20.33%), followed by Central European (20.33%), Carpathian-Balkan (6.77%), and circumpolar (6.77%).Stenochore Alpine (3.37%), Balkan (1.69%), and endemic (1.69%) species are rare. Populations of cosmopolitan species (5.08%) entered the territory under the influence of zoo-anthropogenic factors.

With regard the analysis of the influence of ecological factors (moisture, temperature, soil chemical reaction) the phytocenoses of the association Pulmonario rubrae - Fagetum syringetosum josikaeaehave aspectrum ranging from mesophilic (55.92%) to mesohygrophilous (25.41%), from micro-mesothermic (47.45 %) to microthermal (42.36%), and from acid-neutrophilic (37.28%) to weak acid-neutrophilic (22.03%). Considering the chromosomal karyotype as the basic element, cytogenetic analysis highlights the dominance of diploids (44.06%) closely followed by polyploids (42.37%).

The European beech stands populated with Syringa josikaeahave a high conservative value specific to an endemic habitat found only in the Apuseni Mountains.

Key words: phytocenoses, beech forests, ecological categories, genetic categories.

INTRODUCTION

The European beech stands populated with *Syringa josikaea* grow on irregular and very strong slopes (i.e. 33-45°) with a predominantly eastern orientation, made of crystalline shale rocks with rocklands, talus and scree on surface in a proportion ranging between 30 and 40%, on superficial skeletal soils belonging to dystric cambisols, acid-neutrophilic, oligobasic, moist types of soil. At the base of the slopes on a very narrow alignment bordering the riverbed of the IadăuluiValley, shrublets of *Syringa josikaea* (Transylvanian or Hungarian lilac) grow. We decided to carry out ecological, phytocenological and cytogenetic surveys on these beech forests since they grow in a critical habitat of community interest called 91V0 –

Dacian beech forests (*Symphyto-Fagion* NATURA 2000) which shelter rare, threatened, endangered and at risk of extinction species including *Syringa josikaea*which is a Carpathian tertiary relic and endemic species.

There are forest communities protected within a Botanical nature reserve i.e. ROSCI 0262 included in the Sites of Community Importance (SCIs). Research works on beech stands ecology in the field has not been carried out so far, except studies on the flora and vegetation carried out by Rațiu (1965, 1967), and Rațiu et al. (1984). In previous dedicated publications and based on well-argued criteria, we subordinated the population of *Syringa josikaea* to *Pulmonario rubrae - Fagetum*coenosis (Soó 1964) Täuber 1987 - *syringetosum josikaeae L.* Burescu (2018), even if other authors as Sanda et al. (1999) subordinated it to the *Carici brizoides – Alnetum* association, while Chifu et Irimia (2014) subordinates it to the *Telekio speciosae - Alnetum incanae*coenosis. Ecological and genetic research on beech forests mixed with conifers has been conducted recently in the Western Carpathians by L. Burescu (2013, 2015, 2017, 2018). Research works on virgin forests in Romania with high conservation values, other than the Hungarian/Transylvanian lilac, were conducted over time by Abrudan et al. 2006, Bândiu and Doniță (1988), Bândiu et al. (2001), Biriș (2004), Biriș et al. (2005), Chifu and Ștefan (1992), Chifu et al. (2014), Doniță and Biriș (2001), Giurgiu (2001), Radu (2001), Stăncioiu et al. (2008).

MATERIAL AND METHOD

The study material consists of beech forests (*Fagus sylvatica*) populated with *Syringa josikaea* mixed with conifers (*Abies alba, Picea abies*) located in the Iadului Valley basin, Management unit V Iadului Valley, Forest district Remeți, with the following compartments: 66A Iadolina Waterfall with a surface of 8.7ha, aged 130 years old, located at altitudesranging between 750 and 950 m; 70A Iadolina Waterfall with a surface of 3.0ha, aged 150 years, locatedataltitudesranging between 710 and 800 m; compartment 74 Iadului Valley- Dealul Mare Hill with a surface of 37 ha, aged 120 years, located at altitude ranging between 640 and 1000 m;compartment 78 B Iadului Valley – Savoi with a surface of 4.0 ha, aged 70 years, located at altitudes ranging between 610-800 m; compartment 82 A Iadului Valley- Vâlcei, with a surface of 8.8 ha, aged 140 years, located at altitudes ranging between 590 and 880 m.

In the surveyed forest areas we carried out the floristic inventory, and five phytocenological survey, and the plant species we found were registered in the Association table (see Table 1 below) according to the

Braun - Blanquet scale (1964) and the constant“K” (frequency in the territory).

We analysed the European beech stands populated with *Syringa josikaea*from ecological, phytosociological, and cytogenetical standpoints based on the tables prepared and we highlighted the distribution within the studies phytocenoses of the ecological categories of live forms, phytogeographical elements (geoelements), ecoforms (ecological indices: moisture, temperature, chemical reaction of the), and genetic categories by chromosomal karyotype.

The classification by the types of live forms was made according to the Raunkiaer system (1937) improved by Braun-Blanquet (1964), and by the types of phytogeographic elements according to Meusel et Jäger (1962).

The analysis of the composition of phytocenoses of the European beech stands mixed with *Syringa josikaea* shrubletsby categories of ecological indices was made after the works of the authors Csűrös et al. (1967), Beldie, Chiriță (1967), Sanda et al. (1983, 2003) who adapted the values of the ecological indices for the species from Central Europe performed on a 1 to 9 scale according to Ellenberg (1979) to the pedoclimatic conditions of Romania, using a 1 to 6 scale.

RESULTS AND DISCUSSION

The floristic inventory of European beech stands populated with *Syringa josikaea*, the *Pulmonario rubrae-Fagetum* association (Soó 1964) Täuber 1987,*Syringetosum josikaeae L.*sub-association Burescu 2018 gathers 59 cormophyte plants (see Table 1) of which four species i.e. *Fagus sylvatica*, *Pulmonaria rubra*, *Abies alba*, and *Syringa josikaea* which are specificto the association and sub-associationaforementioned, while 37 species are characteristic and differential for the basic coenotaxa of the coenosis *Symphyto-Fagenion*, *Symphyto cordati-Fagion* (eight species), *Fagetalia sylvaticae*cenosis (11 species), *Querco-Fagetea* (18 species). A number of 13 species are transgressive from other associations namely*Vaccinio-Piceetea* (six species), *Betulo-Adenostyletea* (five species), and *Alnetea glutinosae* (two species) which proves a rich floristic biodiversity (see Table 1).

The tree layer with a general coverage of 60% is dominated by *Fagus sylvatica* accompanied by *Abies alba*, *Picea abies*, *Sorbus aucuparia*, *Acer pseudoplatanus*, *Ulmus glabra*, *Carpinus betulus*, *Betula pendula*, and *Pinus sylvestris*.

Table 1

European beech stands ecology in the association *Pulmonario rubrae - Fagetum* (Soó 1964), Täuber 1987 - *syringetosum josikaeae* L. Burescu 2018

Bio	Phyto. Elem.	M T R Ecological indices			2n (karyotype)	Survey no.	1	2	3	4	5	K
						Compartments	66A	70A	74	78B	82A	
						Altitude (m)	750	710	640	610	590	
						Exposure	E	E	E	NE	E	
						Slope (%)	45	45	33	41	40	
						Tree height (m)	28	18	25	18	18	
						Tree diameter (cm)	50	60	60	80	100	
						Tree canopy density	06	05	08	07	06	
						Grass layer coverage (%)	30	40	50	40	35	
						Surface (ha)	8.7	3.0	37	4.0	8.8	
MPh	E	3	3	0	D	As. *Fagus sylvatica*	3	2	5	4	3	V
H	Carp-B	3.5	2	2	D	As. *Pulmonaria ribra*	+	+	.	.	+	III
MPh	Ec	4	3	0	D	As. *Abies alba*	+	2	.	.	.	II
mPh	End	3.5	2.5	4	D	Subas. *Syringa josikaea*	1	1	+	+	2	V
Symphyto - Fagenion, Symphyto cordati - Fagion												
MPh	Ec	3.5	3	3	P	*Acer pseudoplatanus*	+	+	+	+	+	V
G-H	E-M	4	2	3	D	*Festuca drymeja*	.	.	+	+	+	III
H	Carp-B	3	0	0	D	*Hieracium transylvanicum*	+	.	+	.	.	II
H	Ec	3	2.5	4	D	*Veronica urticifolia*	.	.	.	+	+	II
Ch	Ec	3.5	2	0	D	*Saxifraga cuneifolia*	.	.	.	+	1	II
H	E	3.5	3.5	3.5	P	*Polystichum aculeatum*	+	1	.	.	.	II
H	Ec	4	2.5	4	D	*Aconitum vulparia* ssp. *lasianthum*	.	+	.	.	.	I
H	Carp	4	2	3	D	*Leucanthemum waldsteinii*	.	+	.	.	.	I
Fagetalia sylvaticae												
nPh	Eua	3	2.5	3	P	*Rubus hirtus*	1	3	.	+	+	IV
H-G	Eua	3.5	3	4	D	*Asarum europaeum*	+	+	.	+	+	IV
G-(H)	E	3.5	3	5	P	*Mercurialis perennis*	.	+	+	+	.	III

Continuation Table 1

Bio	Phyto. Elem.	M	T	R	2n (karyotype)	Survey no.	1	2	3	4	5	K
		Ecological indices										
H	Eua (C)	2	3	2	P	*Calamagrostis arundinacea*	1	+	.	.	2	III
G	Eua	3	3	0	P	*Galium odoratum*	.	.	+	+	+	III
H-Ch	Ec	3	0	4	D	*Lamium galeobdolon*	+	.	.	.	+	II
H	Eua	3.5	3	3	P	*Senecio germanicus*	+	.	.	.	+	II
H-G	Cp	4	3	3	D	*Oxalis acetosella*	+	.	+	.	.	II
Th	Eua	4	3	4	D,P	*Impatiens noli-tangere*	.	.	.	+	+	II
Th-TH	Cosm	3.5	3	3	P	*Geranium robertianum*	.	+	.	.	+	II
Th	E	2.5	3	2	P	*Galeopsis tetrahit*	.	+	.	.	.	I
						Querco-Fagetea						
H	Cosm	4	3	0	P	*Dryopteris filix-mas*	+	+	.	+	+	IV
mPh	Balc	3	3	3	D	*Corylus avellana*	.	+	+	1	1	IV
mPh	Eua	3	2.5	0	P	*Spiraea chamaedryfolia*	+	+	.	2	1	IV
MPh	E	3	3	3	P	*Carpinus betulus*	.	.	+	1	+	III
H	Cp	3	3	0	D,P	*Poa nemoralis*	.	+	.	1	1	III
H	Cosm	4	2.5	0	P	*Athyrium filix-femina*	+	+	.	.	+	III
MPh	Eua	4	3	3	P	*Ulmus glabra*	+	+	.	.	.	II
MPh	Eua	3	2	2	P	*Betula pendula*	+	+	.	.	.	II
mPh	Eua	3	3	4	D,P	*Salix capraea*	.	+	.	+	.	II
nPh	Ec	3	2.5	3	P	*Rosa pendulina*	.	.	.	+	+	II
H	E	3.5	3	3	D	*Pulmonaria officinalis*	.	.	.	+	+	II
H	Ec	3.5	2	3	P	*Doronicum austriacum*	+	+	.	.	.	II
H	Eua	3	3	0	D	*Campanula persicifolia*	.	+	.	+	.	II
H	E	2	3	4	CN	*Sedum telephium* ssp. *maxima*	.	.	.	+	+	II
G	Ec	2.5	3	3	P	*Galim schultesii*	.	+	.	+	.	II
H(G)	Eua	3	0	4	D	*Melica nutans*	.	+	.	.	.	I
H	Eua	4	3	3	D,P	*Eupatorium cannabinum*	.	+	.	.	.	I
H	Eua	4	2	0	D-P	*Filipendula ulmaria*	.	.	.	.	+	I
						Vaccinio -Piceetea						
MPh	E	0	0	0	D	*Picea abies*	+	1	.	1	+	IV

ContinuationTable 1

Bio	Phyto. Elem.	M T R Ecological indices			2n (karyotype)	Survey no.	1	2	3	4	5	K
MPh	E	3	2.5	2	D	*Sorbus aucuparia*	+	.	+	.	+	III
H	E	2.5	2.5	2	D,P	*Luzula luzuloides*	.	+	+	+	.	III
MPh	Eua	0	0	0	D	*Pinus sylvestris*	+	+	.	.	.	II
mPh	Alp(E)	3	2	3	D	*Lonicera nigra*	+	.	.	.	+	II
H	Ec	3.5	2.5	2	D	*Luzula sylvatica*	.	.	.	.	+	I
Betula - Adenostyletea												
H	Ec	4	2	4	P	*Gentiana asclepiadea*	.	+	.	.	+	II
G	Alp-Carp-B	3.5	2	3.5	P	*Doronicum columnae*	.	.	.	+	+	II
H	Eua	4	2.5	0	D	*Rubus idaeus*	.	.	.	+	+	II
H	Eua	4	2.5	0	D	*Heracleum sphondylium*	+	.	.	.	.	I
H	Ec	2.5	3	3	P	*Digitalis grandiflora*	.	+	.	.	.	I
Alnetea glutinosae												
H	Cp	3.5	2	3	P	*Dryopteris cristata*	.	+	.	.	+	II
Ch-nPh	Eua	4.5	3	4	P	*Solanum dulcamara*	.	.	.	.	+	I
Variae syntaxa												
G	Eua(M)	2	3	4	D	*Polygonatum odoratum*	.	.	+	+	+	III
MPh	E(M)	3	3	3	P	*Sambucus nigra*	.	.	.	1	+	II
H	Cp	2.5	2	3	D	*Solidago virgaurea*	.	+	.	+	.	II
H	Carp	2.5	2	0	D,P	*Campanula rotundifolia* ssp. *kladniana*	.	+	.	.	+	II
H	Cosm	3	0	4	P	*Asplenium trichomanis*	.	+	.	+	.	II

In one survey there were found the following: *Lonicera xylosteum* (1); *Senecio doria* (1); *Fragaria vesca* (2); *Salix elaeagnos* (5).
Location: 1.Compartment 66A - Iadolina Waterfall, 27.08.2012; 2. Compartment 70A Iadolina Waterfall, 27.08.2012; 3. Compartment 74 – Iadului Valley, Dealul Mare Hill, 27.08.2012; 4. Compartment 78B – Iadului Valley, Savoi, 27.08.2012; 5. Compartment 82A- Iadului Valley; Vâlcei sub Cruce, 27.08.2012.

The thickening of the canopy of the trees is between 0.5-0.8, the diameters of the tree trunks ranges between 50 and 100 cm and the height thereof reaches sizes between 18 and 28 m at ages between 120 and 150 years. The layer of shrubs with a general coverage of 5% consists of*Syringa josikaea*, *Corylus avellana*, *Spiraea chamaedryfolia*, *Salix capraea*, *Sambucus nigra*, *Lonicera nigra*, *Rosa pendulina*, *Salix elaeagnos*, which we included in the sub-association *syringetosum josikaeae*, holotypus hoc loco: see Table 1, survey no.5.

The grass layer cover between 30-50% and consists of 43 species of which *Pulmonaria rubra*, *Festuca drymeja*, *Asarum europaeum*, *Dryopteris filix-mas*, *Athyrium filix-femina*, *Poa nemoralis*, *Calamagrostis arundinacea*, *Galium odoratum*, *Mercurialis perennis*, *Rubus hirtus*, *Luzula luzuloides*, *Polygonatum odoratum*, *Hieracium transsylvanicum*, *Polystichum aculeatum*, *Doronicum austriacum*, *Gentiana asclepiadea*, *Senecio germanicus*, *Galium schultesii*, and others are encountered with a higher frequency (see Table 1).

Analysis of beech phytocenoses with *Syringa josikaea*within Management unit V Iadului Valley, Remeți Forest District, Bihor county, in terms of the ecodiversity of live formsshows the dominance of hemicryptophytes (52.54%) accompanied by phanerophytes (28.78%), geophytes (10.16%), terophytes (5.08%), cameophytes (3.37%) these being the ecological categories best adapted to a temperate-continental climate (see Table 2 below).

Table 2

Ecodiversity of bioforms in beech with *Syringa josikaea*, Apuseni Mountains

Bioforms	Ph of which			H	G	Ch	Th	Total species
	MPh	mPh	nPh					
Species no.	10	5	2	31	6	2	3	59
Percentage %	16.94	8.47	3.37	52.54	10.16	3.37	5.08	100%

Legend: Ph = phanerophytes (woody plants); MPh = megaphanerophytes; mPh = mesophanerophytes; nPh = nanophanerophytes; H = hemicryptophytes; G = geophytes; Ch = cameophytes; Th = annual terophytes.

The analysis of the phytogeographical elements (geoelements) by geographical area shows the dominance of the Eurasian species (32.20%), closely followed by the European ones (20.33), Central European (20.33%) and at a distance by the circumpolar (6.77%), Carpathian (6.77%), and cosmopolitan (6.77%) species. Stenochore species are rare and occur in small percentages such as Alpine (3.37%), Balkan (1.69%), and endemic (1.69%) (see Table3 below).

Table 3

Distribution of phytogeographic elements in European beech standsmixed with *Syringa josikaea* from the Apuseni Mountains

Phytogeographic elements	Eua	E	Ec	Cp	Carp	Cosm	Balc	Alp	End	Total sp.
Species no.	19	12	12	4	4	4	1	2	1	59
Percentage %	32.20	20.33	20.33	6.77	6.77	6.77	1.69	3.37	1.69	100%

Legend: Eua = Eurasian; E = European; Ec = Central European; Cp = circumpolar, Carp = Carpathian, Cosm = cosmopolitan; Balc = Balkan; Alp = alpine; End = endemic.

The analysis of ecological indices (ecological factors) in terms of moisture forthe European beech stands phytocenoses mixed with *Syringa josikaea* highlights the preponderance of mesophilic species (55.92%) followed by mesohygrophilous (25.41%) and xeromesophilic (15.24%) ones. With regard temperature, most species are moderately thermophilic (47.45%) and microthermal (42.36%).

The chemical reaction of the soil stimulates the development of acid-neutrophilic (37.28%), euriionic (27.11%), and weakly acid-neutrophilic (22.03%) species and to a less extent the acidophilic ones (11.86%).

Table 4

Ecological indices of phytocenoses of the association *Pulmonario rubrae - Fagetum*, sub-association *syringetosum josikaeae*, Apuseni Mountains.

Ecol. al Indic.	Values types	2	2.5	3	3.5	4	4.5	5	0	Total sp.
M	Species no.	3	6	19	14	14	1	-	2	59
	Percentage%	5.08	10.16	32.20	23.72	23.72	1.69	-	3,37	100
T	Species no.	13	12	27	1	-	-	-	6	59
	Percentage%	22.03	20.33	45.76	1.69	-	-	-	10,16	100
R	Species no.	7		22		13		1	16	59
	Percentage%	11.86		37.28		22.03		1.69	27.11	100

Legend: M = moisture; T = temperature; R = chemical reaction of the soil; H (2-2.5) = xeromesophilic species; H (3-3.5) mesophilic species; H (4-4.5) = mesohygrophilic species; H (5) = hygrophilic species; H (O) = euryhide species; T (2-2.5) = microthermal species; T (3-3.5) = mesothermal species; T (0) = eurythermal species; R2 = acidophilic species; R (3) = acid-neutrophilic species; R (4) = weak acid-neutrophilic species; R (5) = neutro-basophil species; R (0) = euriionic species.

The distribution of genetic categories by chromosomal karyotype (see Table 5) in the phytocenoses of the European beech stands with*Syringa josikaea* indicates the preponderance of diploid species (44.06%) which are the repository of the gene pool necessary for evolution,closely followed by polyploid species (42.37%) containing genes for land colonization and adaptation to extreme living conditions in a habitat with steep slopes, with rocklands, talus and scree subjected to strong winds, heavy snow and critical temperatures.

Table 5

Genetic ecostructure of European beech stands with *Syringa josikaea* from the Apuseni Mountains, Romania.

Genetic categories	Diploids (D)	Poliploids (P)	Diplo-Poliploids (DP)	Unknown karyotype (CN)	Total species
Species no.	26	25	7	1	59
Percentage %	44.06	42.37	11.86	1.69	100

Relevance

European beech stands with *Syringa josikaea* (Hungarian/ Transylvanian lilac) are rare in Romania and are included in a natural forest ecosystem of community interest for they contain endangered species, which is why they must be protected in special protected areas, Doniță et al. (2005), Gafta, Mountford coord. et al. (2008), banning any felling of trees that could impact the alreadyso fragile stability of these relict, endangered forest ecosystems.

Only special conservation works will be carried out in these forests, to ensure the protection and permanence of rare, endangered, endemic, relict species.

CONCLUSIONS

1. Through our study, we found 59 cormophyte species, of which a number of six species are rare, relict, and endemic, and one an endangered one.
2. European beech stands with *Syringa josikaea* are dominated by hemicryptophytes (52.54%), and phanerophytes (28.78%) which is a manifestation of the belonging of the surveyed territory to the temperate-continental climate of the Apuseni Mountains.
3. Regarding the geographical area, most species are Eurasian (32.20%) followed closely by European (20.33), Central European (20.33%) and in small percentages by Carpathian (6.77%), and circumpolar (6.77%) species. Stenochore species are few and occur in insignificant percentages i.e. Alpine (3.37%), endemic (1.69%), and Balkan (1.69%) species.

4. As a reaction to the action of edaphoclimatic factors, European Beech stands with *Syringa josikaea*manifest a mesophilic (55.92%), mesothermal (47.45%), and acid-neutrophilic (37.38%) nature.
5. Cytogenetic analysis of phytocenosis plants highlights the share of diploid species (44.06%) that store the gene pool necessary for evolution, polyploid ones (42.37%) containing genes that favour adaptation to pedo-climatic conditions of the habitat and colonization of geographical space.
6. Based on the analysis of the floristic composition of the beech stands phytocenosis and taking into account the characteristic and differential species we separated a new sub-association gathering the *Syringa josikaea* shrublets in -*syringetosum josikaeae*, which we subordinated to the basic *Pulmonario rubrae – Fagetum* association.
7. Five tables enclosingscientifically processed statistic data support the paper, which is documented with data from a bibliography comprising 29 scientific titles.

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