PHYTOSOCIOLOGICAL GENETICS SURVEYS ON ECOFORMS, BIOFORMS, PHYTOGEOGRAPHICAL ELEMENTS AND CYTOGENETIC CONSTITUTION IN SPRUCE FORESTS WITH *LEUCANTHEMUM WALDSTEINII* IN THE VLĂDEASA MOUNTAINS, TO ELABORATE THE SUSTAINABLE MANAGEMENT METHOD

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Abstract

The spruce forests with Carpathian chrysanthemum in the Remeti Forest District, management unit (UP) I Boceasa, the compartments us 65, ua 80B, ua 95B, ua 141 B, ua 149 B, were surveyed in terms of floral composition of the tree, bushes, herbaceous, and moss layers. The phytocenosis of the association Leucanthemo waldsteinii-Piceetum are dominated by Picea abies accompanied by Abies alba, Sorbus aucuparia, Acer pseudoplatanus, Fagus sylvatica, in which the hemicryptophites (56%) dominate the bioforms spectrum, the European and Central European (29.6%) and circumpolar (23.8%) species dominate the phytogeographical elements. Regarding the ecological factors (humidity, temperature, soil chemical reaction), Mesophiles (63%), Microterms (57%), acido-Neutrophils (30%) are dominant. Cytogenetic analysis reveals the high share of diploid species (47.6%) and polyploids (46.4%).

Key words: spruce forests, phytocoenoses, ecoforms, genetic categories

INTRODUCTION

Spruce forests with *Leucanthemum waldsteinii* in the Vlădeasa Mountains are spread out on the edge of the shady streams, on the springs dales moistened by spring waters, on mild to steep slopes (25-38°) in the alpine and subalpine floors at an altitude of 1,400-1,700 m.

Spruce forests grow in silky-rock sites on gleisol-soils, wet-watered (slightly watered), slightly acidic to acidophilic soils.

Ecological genetics research on spruce forests (*Picea abies*) with *Leucanthemum waldsteinii* in the Vlădeasa Mountains has not been carried out until recently by Burescu (2011, 2012, 2013, 2015).

Scientific data on the floral composition and research data of the vegetation from the Valea Drăganului valley, the Vlădeasa Mountain massif come from the works of Resmeriţă (1970), Raţiu et Gergely (1970, 1985) Burescu et al. (2004). In Romania, similar topics related researches have also been made by Abrudan et al. (2006), Bândiu and Doniţă (1988), Bândiu et al. (2001), Biriş et al. (2001,2005), Burescu et al. (2004), Chifu and Ştefan (1992), Chifu et al. (2014), Doniţă and Biriş (2001), Radu (2001), Stăncioiu et al. (2008).

MATERIAL AND METHOD

The surveyed material consists of spruce forests (*Picea abies*) with *Leucanthemum waldsteinii* management unit (UP) I Boceasa, Râmeţi Forest District, compartments (Ua) 65 Pârâul Rupturile – Culmea Albanului (1,000-1,400m altitude), Ua 80B, Pârăul Gardului below the Culmea Micău peak (1,450-1,550 m), Ua 95B Pârâul Gropii (1,100-1,650m) UA 141B, Pârâul Moara Dracului (1,250-1,550 m), Ua 149B Pârâul Voiosu below the Cârligate peak (1,450-1,695 m).

Floral inventory was carried out in the surveyed forest areas, and the identified species were transferred to the association table along with the assessment of abundance and dominance according to Braun-Blanquet cover-abundance scale (1964).

Spruce forests with *Leucanthemum walsteinii* were surveyed ecologically and genetically on the basis of the tables of bioforms, the phytogeographical area, the distribution of the ecoforms and the distribution of the genetic categories in the *Picea abies* phytocoenoses. The classification of bioforms was made after Raunkiaer (1937) and the phytogeographical elements of Mensel and Jäger (1992).

The analysis and interpretation of the results are my personal and original contributions.

RESULTS AND DISCUSSION

The phytocenoses of the spruce forests with Carpathian chrysanthemum, the *Leucanthemo waldsteinii* - *Piceetum* vegetal association, are made up of boreal, European, circumpolar, Carpathian, microterms, mesophilic-mesohigrophilic, acid and weak acid species.

The tree layer consists almost exclusively of spruce (*Picea abies*) accompanied by rare specimens of *Abies alba*, *Sorbus aucuparia*, *Acer pseudoplatanus*, *Fagus sylvatica*, it has a total coverage of 53%, heights of 20-26 m, diameters of 25-40 cm and aged 100-110 years.

The layer of poorly developed shrubs is represented by *Salix silesiaca*, *Alnus viridis*, *Sambucus racemosa*, *Juniperus communis*, *Daphne mezereum*, *Lonicera nigra*, *Spiraea chamaedrifolia*, *Rosa pendulina*, and *Rubus idaeus*.

The highly developed herbaceous and undergrowth layer of *Leucanthemum waldsteinii*, *Luzula sylvatica* and *Vaccinium myrtillus* types has a 65% overall coverage and includes 84 species (Table 1), a rich biodiversity of which 15 species are rare, endangered, vulnerable, endemic, and relicts i.e. *Aconitum callibotrione*, *Aconitum vulgaria*, *Adenostyles alliariae*, *Angelica archangelica*, *Athyrium distentifolium*, *Dryopteris cristata*, *Heracleum palmatum, Laserpitium krapfii, Leucanthemum waldsteinii, Saxifraga heucherifolia*, *Streptopus amplexifolius*, *Soladanella montana*, included on red lists by Boşcaiu et al. (1994), Oltean et al. (1994), which gives these forests a very high preservation value Doniţă et al. (2005).

The moss layer is dominated by *Polytrichum juniperinum* associated with *Sphagnum girgensohnii*, *Hylocomium splendens*, and it almost completely covers the soil.

A number of 46 species form the core of the cenotaxa *Chrysanthemo rotundifolii-Piceeion*, *Athyrio-Piceetalia*, *Vaccinio-Piceetia* subordinated of the association *Leucanthemo waldsteinii-Piceetum* and another 36 species come in the association from the *Betulo-Adenostyletea*, *Querco-Fagetea* classes.

The analysis of phytocenoses of association *Leucanthemo waldsteinii-Piceetum* shows that the Hemicryptophytes (56%) dominate in the spectrum of bioforms (Table 2) followed by Phanerophytes (20,76%) and Geophytes (16,6%) since they best adapted species to temperate-continental climate.

Table 2

Bioforms spectrum in *Leucanthemum* spruce forests in the Vlădeasa Mountains

Bioforms	Ph of which				Ch	H	G	T		Total species
	MPh	mPh	nPh	l-nPh				TH	Th	
Species no	5	7	4	1	4	47	14	1	1	84
Share %	5.9	8.2	4.76	1.9	4.76	55.9	16.6	1.9	1.9	100

Legend: Ph= Phanerophytes; MPh=Megaphanerophytes; mPh=Mesophanerophytes; nPh= Nanophanerophytes; l-nPh=liana (climbing plants).

With regard to the genetic origin centre and the present geographic area of the species (Table 3), the phytogeographical elements are dominated by European and Central European (29,6%), circumpolar (23,8%), Eurasian (20,3) Balkan-Carpathian, and Alpino-Carpathian (16,6%) plant species, followed at some distance by endemic species (6%), specific to some settlements of the ancient Dacia.

Table 3

Phytogeographical elements spectrum in the spruce forests with *Leucanthemum* in the Vlădeasa Mountains

	Cp	Eua	E	Ec	Carp-B	Alp-Carp-B	End	Cosm	Total species
Phytogeographical elements	20	17	12	13	6	8	5	3	84
	23.8	20.23	14.2	15.4	7.14	9.51	5.95	3.57	100

Legend: Cp=Circumpolar; Eua=Eurasian; E=European; Ec=Central European; Carp-B=Balkan-Carpathian; Alp-Carp-B=Alpine-Carpathian-Balkan; End=Endemic; Cosm=Cosmopolite.

The analysis of ecoforms (Table 4) shows that in terms of soils humidity the following species are dominant: Mesophils (63%), and mesohigrophils (27.4%), in terms of temperature: Microtermes (57%), Mesotermes (21.4%), and in terms of chemical reaction: acid Neutrophils (30%),and Acidophils (26%).

Table 4

Ecological forms of HTR (ecological indices) in the phytocenoses of *Leucanthemum* spruce forests in Vlădeasa Mountains

Ecological indices	Values categories	1	1.5	2	2.5	3	3.5	4	4.5	5	0
H	Species no	-	-	1	1	24	29	20	3	1	5
	%	-	-	1.14	1.4	28.5	34.5	23.8	3.57	1.14	5.95
T	Species no	-	3	25	22	17	1	2	-	-	14
	%	-	3.57	29.7	27.3	20.23	1.14	1.19	-		16.6
R	Species no	6		16		25		17		-	20
	%	7.1		19		29.7		20.23		-	23.8

Legend: H=Humidity; H2-2.5=Xeromesophils; H3-3.5=Mesophils; H4-4.5=Meso-hygrophila; H5=Hygrophila; H0= Eurihidre; T1.5=Cryophyte; T2-2.5= Microtermes; T3-3.5=Micro-mesoterms; T0=Euriterms; R1.5= strong Acidophiles; R2 = Acidophiles; R3= acid Neutrophils; R4= weak acid Neutrophils; R0= Euriionic.

Regarding the genetic categories (Table 5), diploid species (47.6) are dominant and are storing in their genes the reserve necessary for species evolution, followed closely by polyploids (46.4%) as they are the bioforms with genes favoring both field colonization and adaptation to the conditions of the environment.

Table 5

Distribution of genetic categories in *Leucanthemum* spruces in the Vlădeasa Mountains

Genetic categories	Diploid D	Polyploids P	Diplo-polyploids D-P	Unknown karytype CN	Total species
Species no	40	39	4	1	84
(%)	47.6	46.4	4.76	1.14	100

Legend: D=Diploids; P= Polyploids; D,P=Diplo-polyploids; CN= Unknown karytype

There are genetically differentiated 3 phenotypic, anthropological, morphological, physiological varieties in the spruce population (*Picea abies*) in the Vlădeasa Mountains in terms of crown shape, tree branching, wood density, rapidity of growth, the number of chloroplatins in the cell plastidom in response to the climatic and soil-related factors, altitude, solar radiation and pressures of natural selection.

The pyramidal-columnar phenotypic variety expresses the plant population characteristics manifested by genes thereof providing resistance to wind and ice, fast growth pace, low wood density, snow sensitivity which are all specific to spruce forests with *Leucanthemum waldsteinii* on valleys and streams in contrast to those on steep slopes with rocks and high peaks.

Economic importance

Boreal spruce forests with *Leucanthemum waldsteinii* are included in or contain natural habitats of community interest: Habitat R4209 - South-eastern Carpathian spruce forests (*Picea abies*) *with Leucanthemum waldsteinii* which need to be protected by declaration thereof as protected natural areas, Doniţă et al. (2005), Gafta, Mountford coord. et al. (2008). There are virgin secular forests included in the Group I, forest vegetation with special protection features, categories 1-5j, 1-5i, 1-3f, 1-2a, 1-2c, playing an important role in the protection of river basins, soil erosion control, climate adjustments.

Although important for the wood industry, any kind of cutting is forbidden in these forests and only preservation works will be carried out favoring the maintenance of rare, endangered, endemic species in the ecosystem and regeneration from advance growth of forest species.

CONCLUSIONS

1. In our survey we identified 84 plant species of which 15 species rare, vulnerable, relict, endemic and which habitat is in a rare forest ecosystem declared natural habitat of community interest.

2. In the phytocoenoses of spruce forests with *Leucanthemum waldsteinii*, hemicryptophilic species (56%) are dominant in terms of number as a consequence of the belonging of the surveyed territory to the temperate continental region specific climate. Phanerophytes (20.76%), although less numerous, provides the physiognomy of phytocoenoses of spruce forests with Carpathian chrysanthemum.

3. Regarding the genetic origin center and geographical area, the phytogeographical elements background is dominated by European and Central European species (29.6%), followed by Circumpolar and Boreal ones (23.8%), and the Carpathian-Balkan along with Alpine-Carpathian-Balkan (16.65%) species, located in the cold and wet forests stations.

4. The analysis of ecoforms (ecological indices) on humidity, temperature, chemical reaction of the soil, points out the dominance of Mesophils (63%), Microtermes (57%), acid Neutrophils (30%) in the spruce forests with Carpathian chrysanthemum.

5. In terms of cytogenetic analysis of the karyotype, spruce dominates the diploid species (47.6%) which stores the reserve of genes required to species evolution followed closely by polyploids (46.4%), which favours the colonization of fields and adaptation to environmental conditions.

6. Spruce pyramidal and columnar phenotypic variety is different from that on steep rocky slopes and high peaks within the surveyed territory since it is the expression of single genes to the action of genetic structure modifiers of the *Picea abies* spruce population.

Table 1

The ecoforms, bioforms, phytogeographical elements and spruce karyotypes with *Leucanthemum waldsteinii*

Bio	Phyt. El.	H (ecological indices)	T	R	2n	Compartments surveyed	Ua65	Ua80B	Ua95B	Ua141B	Ua149B	K
						Altitude (m)	1450	1450	1500	1500	1450	
						Exposition	N	V	E	N	N	
						Slope (°)	45	30	25	45	38	
						Tree height (m)	23	25	26	22	22	
						Diameter (cm)	38	42	40	35	46	
						Consistency	0.5	0.6	0.6	0.6	0.5	
						Herbaceous layer covering (%)	50	80	50	80	80	
						Surface (ha)	29.1	14.8	34.5	9.7	13	
H	Carp	4	2	3	D	*Leucanthemum waldsteinii*	+	+	1	+	1	V
MPh	Eua	0	0	0	D	*Picea abies*	3	4	4	3	4	V
						Chrysanthemo rotundifolii-Piceeion						
H	Eua	4	3	2	D	*Hypericum maculatum*	+	+	+	+	+	V
H	E	3.5	2.5	0	D	*Ranunculus platanifolius*	.	.	+	+	+	III
G	Eua	4	2.5	4	P	*Veratrum album*	.	.	+	+	+	III
G	Cp	4	2	2	P	*Streptopus amplexifolius*	.	.	.	+	+	II
G	Eua	3	0	4	D	*Lilium martagon*	.	.	.	.	+	I
						Athyrio-Piceetalia						
H	Cosm	4	2.5	0	P	*Athyrium filix-femina*	+	+	+	.	+	III
H	Ec(Alp)	3.5	2	1.5	P	*Soldanella montana*	.	.	+	.	+	II
H	Cp	4	3.5	0	P	*Dryopteris spinulosa*	.	.	.	+	+	II
MPh	Ec	4	3	0	D	*Abies alba*	+	.	.	+	.	II
H	Cp-A-a	3	1.5	4.5	D	*Polystichum lonchitis*	.	.	+	+	.	II
nPh	Ec	3	2.5	3	P	*Rosa pendulina*	+	.	+	.	.	II
H-Ch	Alp-B	0	3	4	P	*Mercurialis perennis*	.	.	+	.	+	II
H	Ec	3	0	4.5	D	*Valeriana tripteris*	.	.	.	+	.	I
nPh	Eua	3.5	3	3	D	*Daphne mezereum*	+	.	.	.	.	I
						Vaccinio-Piceetea						

*Table 1*continuation

Bio	Phyt. El.	H	T	R	2n	Compartments surveyed	Ua65	Ua80B	Ua95B	Ua141B	Ua149B	K
		(ecological indices)										
H	Ec	3,5	2,5	2	D,P	*Luzula sylvatica*	+	2	2	1	+	V
Ch-nPh	Cp	0	2	1	D	*Vaccinium myrtillus*	2	+	2	+	2	V
H-H	Cp	4	3	3	D	*Oxalis acetosella*	1	+	+	+	1	V
MPh	E	3	2.5	2	D	*Sorbus aucuparia*	+	+	+	+	+	V
H	Eua	4	2.5	1.5	D	*Calamagrostis villosa*	2	2	1	3	.	IV
						Polytrichum juniperinum	2	.	2	3	2	IV
						Sphagnum girgensohnii	1	.	1	2	2	IV
H	E-Alp	3.5	2.5	2.5	P	*Homogyne alpina*	+	+	1	.	1	IV
H	Carp-B	3	0	0	D	*Hieracium transsylvanicum*	+	.	+	.	+	III
H	Cp	0	0	1	P	*Dechampsia flexuosa*	+	.	+	+	.	III
G	Cp	3.5	2	2	P	*Phegopteris conectilis*	+	.	+	.	+	III
mPh	Cp	3	2	3	P	*Sambucus racemosa*	+	.	+	.	+	III
mPh	Ec	3	2	3	D	*Lonicera nigra*	+	.	+	+	.	III
Ch	Cp	4	25	2	P	*Lycopodium annotinum*	+	.	+	.	+	III
						Hylocomium splendens	2	.	.	1	+	III
H	End	3.5	2	2	P	*Campanula abietina*	+	.	+	.	.	II
mPh	Cp-Bo	2	0	0	D	*Juniperus communis*	.	.	.	+	+	II
H	E	2.5	2.5	2	D,P	*Luzula luzuloides*	+	+	.	.	.	II
G	Ec	3	2.5	0	D	*Prenanthes purpurea*	.	.	.	+	+	II
H	Cp-Arct	3.5	1.5	3	P	*Athyrium distentifolium*	.	.	+	.	+	II
H	Cp	3.5	0	0	P	*Dryopteris dilatata*	.	.	+	+	.	II
Ch	Cosm	3.5	2	2	P	*Huperzia selago*	.	.	+	+	.	II
G	Eua	3	3	0	P	*Majanthemum bifolium*	.	.	+	.	+	II
H	Alp-Carp-B	4	2	2	P	*Soldanella major*	+	+	.	.	.	II
H	Alp-Carp-B	0	0	3	D	*Laserpitium krapfii*	.	.	.	+	+	II
H-G	Cp	3	2	2.5	D	*Moneses uniflora*	+	.	.	.	.	I
Th	Eua	3	0	1.5	D	*Melampyrum sylvaticum*	+	.	.	.	.	I

Table 1 continuation

Bio	Phyt. El.	H (ecological indices)	T	R	2n	Compartments surveyed	Ua65	Ua80B	Ua95B	Ua141B	Ua149B	K
l-nPh	Eua-A-a	3	2	2	D	*Clematis alpina*	+	.	.	.	.	I
H	Alp-Carp-B	3	4	4	D	*Euphorbia carniolica*	+	.	.	.	.	I
						Betulo-Adenostyletea						
H	End	4	2.5	0	D	*Heracleum palmatum*	.	.	+	+	+	III
H(G)	Carp-B	3.5	2	0	D	*Adenostyles alliariae*	.	.	+	+	+	III
nPh	Cp-Bo	3	3	3	D,P	*Rubus idaeus*	+	.	+	+	+	IV
TH-H	Eua-Bo	4.5	2.5	0	D	*Angelica archangelica*	.	+	+	.	.	II
H	Cp	3.5	2	3	P	*Dryopteris cristata*	.	+	.	.	+	II
H	Alp-Carp-B	3.5	1.5	4	D	*Aconitum degenii (A. paniculatum)*	.	.	+	.	+	II
H	Eua	3.5	3	3	P	*Senecio germanicus*	.	.	+	+	.	II
H	Ec	3.5	2	3	P	*Doronicum austriacum*	.	.	+	.	+	II
H	Carp-B	2.5	2.5	4.5	P	*Aconitum callibotrion*	.	+	.	+	.	II
H	Cp	4.5	0	4.5	P	*Geum rivale*	.	.	+	.	.	I
H	Ec	4.5	2	0	D	*Cherophyllum hirsutum*	.	.	+	.	.	I
H	Ec	4	2	4	P	*Gentiana asclepiadea*	.	.	.	+	.	I
G	Eua	3.5	0	0	P	*Petasites albus*	.	.	.	+	.	I
G	Alp-Carp-B	3.5	2	3.5	P	*Doronicum columnae*	.	.	.	+	.	I
H	Carp-B	3.5	0	4.5	D	*Saxifraga heucherifolia*	.	.	.	.	.	+
						Querco-Fagetea						
G-H	E-M	4	2	3	D	*Festuca drymeja*	1	.	+	.	1	III
MPh	E	3	3	0	D	*Fagus sylvatica*	.	+	+	.	+	III
H-G	Eua	3.5	3	4	D	*Asarum europaeum*	.	.	+	+	+	III
H	E	3.5	3	3	D	*Stellaria nemorum*	.	+	+	.	+	III
H	End	3	2	3	-	*Aconitum moldavicum*	.	.	+	+	+	III
H	E	3	0	3	P	*Hieracium murorum*	+	.	.	.	+	II
nPh	Eua	3	2,5	3	P	*Rubus hirtus*	+	.	.	.	+	II
MPh	Ec	3,5	3	3	P	*Acer pseudoplatanus*	.	+	.	.	+	II

Table 1 continuation

Bio	Phyt. El.	H (ecological indices)	T	R	2n	Compartments surveyed	Ua65	Ua80B	Ua95B	Ua141B	Ua149B	K
H	Cosm	4	3	0	P	*Dryopteris felix-mas*	.	+	+	.	.	II
H	Carp-B	3,5	2	3	D	*Pulmonaria rubra*	.	.	+	.	+	II
H-G	End	3	2	3	D	*Symphytum cordatum*	.	.	+	+	.	II
G	E	3.5	4	0	P	*Anemone nemorosa*	.	.	+	.	+	II
H	E	3.5	3	3	D	*Myosotis sylvatica*	.	.	.	+	+	II
G	E	3	2.5	2.5	D	*Polygonatum verticillatum*	.	.	.	.	+	I
H	Eua	3.5	0	4	P	*Paris quadrifolia*	.	.	.	.	+	I
H	Ec	4	2.5	4	D	*Aconitum vulparia*	.	.	+	.	.	I
mPh	Eua	3	2.5	0	P	*Spiraea chamaedrifolia*	.	.	.	+	.	I
G	End	4	2.5	4	P	*Dentaria glanduligera*	.	.	.	.	+	I
H(Hh)	Cp	3.5	3	4	P	*Carex sylvatica*	+	.	.	.	.	I
G	Ec	4	3	3	D	*Leucojum verum*	.	1	.	.	.	I
mPh	Eua	3	3	4	D,P	*Salix capraea*	.	.	.	+	.	I
						Variae syntaxa						
H	Cp	5	2	0	P	*Caltha palustris*	+	.	+	.	+	III
mPh	Alp-Carp-B	4	2	2	D	*Salix silesiaca*	.	.	+	+	+	III
mPh	Alp-Carp-B	4	2.5	3	P	*Alnus viridis*	.	.	.	.	+	I
Ch	E	3.5	2.5	3	D	*Veronica montana*	.	.	.	.	+	I
H	Cp-Arct	3.5	2	1.5	P	*Cistopteris sudetica*	.	.	.	+	.	I

Place and date of survey: Compartments Ua 65 – Pârâul Rupturile Valea Crăciunului, 02.07.2013; Compartment Ua80B – Pârâul Gardului below Culmea Micău peak, 10.07.2013; Compartment 95B – Pârâul Buceasa below Vârful Boceasa peak, 17.07.2013; Compartment Ua 141 B – Pârâul Moara Dracului below Culmea Gruieșu peak, 17.07.2013; Compartment Ua 149B – Pârâul Voiosu below Culmea Cârligate, 20.07.2013.

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