CONTRIBUTIONS TO THE STUDY OF BEECH STANDS DEVELOPED BY *FAGUS SYLVATICA* AND *FESTUCA DRYMEJA* IN THE WESTERN CARPATHIANS, THE BIHARIA MASSIF, AND THE GAINA MOUNTAIN

Ana-Maria BUIA[1#], Petru BURESCU[2]

[1] *University of Oradea Faculty of Medicine and Pharmacy, Doctoral School of Biomedical Sciences, "Piața 1 Decembrie" Square, no 10, Bihor County, Oradea, Romania*

[2]*University of Oradea, Faculty of Environmental Protection, Oradea City, Maghru 26, 410087, Romania Institution*

RESEARCH ARTICLE

Abstract

Phytocoenoses of the Festuco drymejae-Fagetum association develop in all the Romanian Carpathians, throughout sites at altitudes between 800 and 1,300 m, peaks with medium to steep slopes ranging from 16° to 36º, with varied exposures. The lithological substrate consists mainly of crystalline shales on which moderately to weakly acidic and slightly moist oligobasic districambosoils, formed. The floristic index of the association includes a number of 73 species, which shows a high biodiversity.

The phytocoenoses of this association are dominated by hemicryptophytes (47.94%), followed by geophytes (28.76%) and phanerophytes (15.06%), and with regard the geographical area of the association, Eurasian species are dominant (38.35%), followed by European (20.54%), Central European (13.69%) and Circumpolar (12.32%) species. Regarding the ecological factors, in terms of soil moisture, mesophilic species are dominant (72.59%), with regard the temperature, micro-mesothermic species predominate (56.15%), and as far as the chemical reaction of the soil is concerned, acid-neutrophils (35.61%) are dominant. The karyological spectrum shows that polyploid species are dominant (56.16%), followed by diploids (30.13%). These meadows have a high ecological value since they shelter four rare, endangered species included on the red lists.

The study of this association founded in the surveyed territory - alongside the analysis of bioforms, floristic elements, ecological indices, the economic analysis and the interpretation of cytogenetic character - provides some important information regarding the habitat conditions, and the economic, ecological and scientific relevance of the phytotaxa found in the field.

Keywords: phytocenoses, bioforms, floristic elements, ecological indices, karyotype
#Corresponding author: anamariabuia@yahoo.com

INTRODUCTION

Research on beech stands subordinated to the *Festuco drymejae-Fagetum* association was carried out in the Biharia Massif, the part included in Bihor county and Mount Gaina in Arad county.

From the literature we reviewed, in-depth research papers on beech forests with *Festuca drymeja* were relatively few in Romania namely in: Sinca Noua, Tarcu, Godeanu and Cerna Mountains, Plopis Mountains, Zarandului Mountains, Somesul Cald Valley, Iadului Valley, Transylvania, Piatra Craiului, Cluj County, Bucegi Mountains, Oituz Valley, Tasnad Hills, Codru-Moma Mountains, Orastie Valley river basin, and northern part of Bihor Mountains.

This association spreads widely throughout the surveyed territory, being described in Vartop, Baita, Cristior Valley, Runcului Hills, Lespedioara Peak, Paraul Mare, the upper basin of Halmagel Valley, Gaina Valley and Leucii Valley.

Research on the flora and vegetation of the forests growing in the areas adjacent to the surveyed territory was carried out on the occasion of incursions and trips made in the territory by the great botanists Marossy (1973, 1975), Boscaiu et Marossy (1979), Ursu et Olaru (), Ursu (2013), the last two paper works being founded on the research conducted in the basin of the Ariesul Mare river and Ariesul Mic river valleys.

The aim of the research was to carry out a phytocenological, ecological and bioeconomic study of the beech stands in the Apuseni Mountains, and in order to achieve this goal we aim to attain several objectives as follows:

– Revealing the floristic composition of the phytocoenoses of the *Festuco drymejae-Fagetum* association,

- Making the ecological characterization of the phytocenoses of the cenose from the perspective of the share of bioforms, floristic elements, ecological indices (soil moisture, air temperature, and chemical reaction of the soil), and genetic karyotype,
- Economic relevance of beech stands and the protective role of the habitat.

MATERIAL AND METHOD

The material subjected to research consists of moderately to weakly acidic and slightly moist oligobasic districambosoils, formed mainly on crystalline on slopes with predominantly southern exposure, with slopes ranging from 16˚ to 36˚.

We carried out in total 20 phytocenological surveys in the most representative phytocenoses, over the years 2018-2021, and we gathered 10 of them in the association table. In this table (see Table 1) we inputted all the species we found, by corresponding coenotaxonomic units, suballiance, alliance, order, and class according to (Sanda et al., 2008), according to their consistency (K), in accordance with the indications of some famous authors (Borza et Boşcaiu, 1965), (Cristea et al., 2004), while having the ecological-floristic systems criteria elaborated by (Tüxen, 1955), (Braun-Blanquet. 1964), and based on the information from some works published more recently according to the authors (Coldea et al., 1997), (Oberdorfer, 1992), (Borhidi, 2003), (Sanda et al., 2008), (Chifu et al., 2014). The quantitative criterion we pursued in the research of phytocenoses is the abundance and dominance of individuals, according to the system developed by (Braun-Blanquet et Pavillard, 1928), with a grading scale from +,1,2,3,4,5, quantified in percentages ranging from 5 to 100%. We analyzed, and characterized ecologically, phytocenologically and cytogenetically the phytocenosis of the *Festuco drymejae-Fagetum* association based on the association table (see Table 1), and histograms with reference to the distribution of bioforms, floristic elements, ecological indices, and genetic karyotypes.

We found and described the association based on the floristic criterion, with the help of the characteristic, indicator, dominant and differential species. The name of the associations is in accordance with the provisions established by the Code of Phytosociological Nomenclature elaborated by (Weber et al., 2000).

Information on the value of ecological indices, bioforms and phytogeographic elements are presented according to (Sanda et al, 2003), (Meusel et Jäger, 1992), (Cristea et al., 2004), (Burescu et Toma, 2005). Data regarding the karyotype of the species were taken over from (Majovsky et Murin, 1987), (Sanda et al., 2003), (Ciocârlan, 2009), (Moore, 2009).

To assess the economic relevance of plants, we used the information from "Flora României" magazine (1952-1976) as well as information from the work (Ciocârlan, 2009), to which we added our observations and findings regarding the use of plants by the local people, but also the protection role that these beech stands provide.

To establish the status of rare, vulnerable, endangered, endemic species we used the "Red Lists" prepared by (Boşcaiu et al., 1994), (Oltean et al., 1994), (Dihoru et Negrean, 2009), and the “European red list of vascular plants” (Bilz et al., 2011).

RESULTS AND DISCUSSIONS

The floristic composition of the beech stands with *Carex pilosa* with counts 73 species, showing a high biodiversity. The species developing the phytocenosis are *Fagus sylvatica* and *Festuca drymeja* in a codominance relationship. The remaining species are subordinated to the suballiance Symphyto Fagenion, the alliance ***Symphyto Fagenion***, the alliance ***Symphyto cordati- Fagion*** (*Polystichum aculeatum, Gymnocarpium dryopteris, Euphorbia carniolica, Cephalanthera longifolia, Epipactis atrorubens, Veronica urticifolia, Dentaria glandulosa, Pulmonaria rubra*), the order ***Fagetalia sylvaticae*** (*Lamium galeobdolon, Oxalis acetosella, Galium odoratum, Dentaria bulbifera, Mercurialis perennis, Lathrea squamaria, Galeopsis speciosa*) and the class ***Querco- Fagetea*** (*Mycelis muralis, Athyrium filix- femina, Viola reichenbachiana, Scrophularia nodosa, Veronica officinalis, Brachypodium sylvaticum*). In the association there are found transgressive species from the classes ***Epilobietea angustifolii*** (*Rubus idaeus, Solidago virgaurea, Atropa belladonna, Hypericum perforatum*), ***Betulo-Adenostyletea*** (*Luzula luzuloides, Gentiana asclepiadea, Petasites albus, Doronicum columnae, Veratum album, Doronicum austriacum*) and ***Vaccinio-Piceetea*** (*Picea abies, Dryopteris cristata, Luzula sylvatica, Vaccinium myrtillus, Polytricum commune*).

Table 1

***Festuco drymejae-Fagetum* Morariu et al. 196**

Lifeform	Floristic elements	M	T	R	G												K	ADm
						Survey no.	1	2	3	4	5	6	7	8	9	10		
						Altitude (mamsl)	800	1170	900	980	1130	1190	800	1270	870	650		
						Exposure	V	SE	SV	S	S	S	SE	E	E	E		
						Slope (º)	30	28	26	18	16	20	70	24	22	36		
						Tree layer density	0.7	0.8	0.7	0.7	0.8	0.7	0.7	0.8	0.7	0.7		
						Tree height (m)	24	20	28	20	24	28	20	20	30	22		
						Tree diameter (cm)	60	40	36	24	28	40	28	24	54	40		
						Tree layer coverage (%)	-	1	-	-	-	-	-	-	-	-		
						Grass layer coverage (%)	20	40	90	80	60	70	30	40	50	70		
						Area (mpx10)	80	120	80	40	80	40	40	80	40	80		
G-H	Ec	4	2	3	D	*As. Festuca drimeja*	+	4	5	4	2	4	3	1	5	5	V	51.05
MPh	E	3	3	0	D	*As. Fagus sylvatica*	4	4	4	4	5	4	4	5	5	5	V	72.5
						Symphyto fagenion- Symphyto cordati- Fagion												
H	Eua	3.5	3.5	3.5	P	*Polystichum aculeatum*	+	.	+	.	+	.	+	.	+	+	III	0.3
MPh	Ec	3.5	3	3	P	*Acer pseudoplatanus*	.	+	+	.	.	+	.	.	+	.	II	0.2
G	Cp	3	2.5	2	P	*Gymnocarpium dryopteris*	+	.	.	.	.	+	.	+	+	.	II	0.2
MPh	Ec	4	3	0	D	*Abies alba*	.	1	+	.	.	.	.	.	.	.	I	0.55
H	Alp-Carp-B	3	4	4	DP	*Euphorbia carniolica*	.	+	.	.	.	.	.	.	.	.	I	0.05
G	E	2.5	3	4	P	*Cephalantera longifolia*	.	+	+	.	.	.	.	.	.	.	I	0.1
G	Eua	2	0	4.5	P	*Epipactis atrorubens*	.	.	+	.	.	.	.	.	.	.	I	0.05
H	Ec	3	2.5	4	D	*Veronica uticifolia*	.	.	.	.	.	+	.	.	.	.	I	0.05
						Fagetalia sylvaticae												
nPh	E	3	2.5	3	P	*Rubus hyrtus*	+	.	+	+	+	1	+	+	.	+	IV	0.85
H-Ch	Ec	3	0	4	D	*Lamium galeobdolon*	+	+	+	.	+	.	+	+	+	+	IV	0.35
G	Eua	3	3	3	P	*Galium odoratum*	.	+	+	+	+	+	.	.	+	+	IV	0.35
H-G	Cp	4	3	3	D	*Oxalis acetosella*	+	.	+	.	+	.	.	+	+	+	III	0.3
Th	Eua	3	2	0	D	*Galeopsis speciosa*	+	.	.	.	.	.	+	.	+	.	II	0.15
G	Ec	3	3	4	P	*Dentaria bulbifera*	.	.	+	+	+	.	.	+	.	.	II	0.2
H-G	E	3.5	3	5	P	*Mercurialis perenis*	.	+	+	.	.	.	.	.	+	+	II	0.2
G	Eua	3	3	3	P	*Lathraea squamaria*	.	.	.	+	.	.	.	.	.	.	I	0.05

Table 1 Continuation

H	Eua	4	3	0	P	*Dryopteris filix- mas*	.	.	+	.	.	.	+	.	+	.	II	0.15
H	Eua	3.5	3	3	P	*Senecio nemorensis ssp.jacquinianus*	.	.	.	.	.	+	.	+	+	.	II	0.15
G	Eua	3.5	3	4	D	*Circea lutetiana*	+	.	+	+	+	.	.	.	+	.	II	0.25
H-Hh	Cp	3.5	3	4	P	*Carex sylvatica*	+	+	.	.	+	.	.	.	+	.	II	0.2
H	Eua	3.5	3	4	D	*Salvia glutinosa*	.	+	+	.	.	.	+	.	.	.	II	0.15
Ch	Ec-SM	3	3.5	4	DP	*Euphorbia amigdaloides*	.	.	+	.	.	.	.	.	.	+	I	0.1
H	Eua	3.5	3	4	DP	*Asarum europaeum*	.	+	+	.	.	.	.	.	.	.	I	0.1
G	Eua	3	2.5	2.5	P	*Polygonatum verticilatum*	.	.	.	+	.	.	.	+	.	.	I	0.1
H	Eua	3	0	3.5	P	*Epilobium montanum*	.	+	.	.	.	.	.	+	.	.	I	0.1
H	Eua	3.5	0	0	P	*Stachys sylvatica*	.	.	.	.	.	.	.	.	+	.	I	0.05
nPh	Eua	3.5	3	3	D	*Daphne mezereum*	.	+	.	.	.	.	.	.	.	.	I	0.05
H	Eua	3	3	3	D	*Lathyrus vernus*	.	+	.	.	.	.	.	.	.	.	I	0.05
Th-TH	Cosm	3.5	3	3	P	*Geranium robertianum*	.	.	+	.	.	.	.	.	.	.	I	0.05
H	E	4.5	3	3	P	*Carex remota*	.	.	+	.	.	.	.	.	.	.	I	0.05
H	Atl-M	3.5	3	4	D	*Sanicula europaea*	.	.	+	.	.	.	.	.	.	.	I	0.05
G	Eua	3	0	4	D	*Lilium martagon*	.	.	.	.	.	+	.	.	.	.	I	0.05
nPh	E	3	3	4	P	*Euonimus latifolium*	.	.	.	.	.	.	.	.	.	+	I	0.05
H	Eua	3,5	0	4	P	*Paris quadrifolia*	.	.	.	.	.	.	.	.	+	.	I	0.05
						Querco- Fagetea												
H	E	3	3	3	D	*Mycelis muralis*	+	+	+	.	+	+	+	.	.	.	IV	0.3
H	Cosm	4	2.5	0	P	*Athyrium filix- femina*	+	.	.	+	+	+	.	.	+	.	III	0.25
H	Eua	3	2.5	3	P	*Viola reichembachiana*	.	.	.	+	.	.	.	.	.	.	I	0.05
H	Eua	3.5	3	0	P	*Scrophularia nodosa*	.	.	+	+	.	+	.	.	+	.	II	0.2
Ch	Eua	2	2	2	P	*Veronica officinalis*	.	+	.	.	.	.	.	.	.	.	I	0.05
H	Eua-M	3	3	4	DP	*Brachypolium sylvaticum*	.	+	.	.	.	.	.	.	.	.	I	0.05
H	Eua	3	2.5	0	D	*Fragaria vesca*	.	+	.	.	.	.	.	.	.	.	I	0.05
l-nPh	Atl-M	3	3	3	P	*Hedera helix*	.	.	+	.	.	.	.	.	.	.	I	0.05
MPh	E	3	3	0	DP	*Acer platanoides*	.	.	.	.	.	.	.	.	.	+	I	0.5
mPh	E	3	3	3	D	*Corylus avellana*	.	.	+	+	.	.	.	.	.	.	I	0.1
G	Eua	3.5	0	3	P	*Plathantera bifolia*	.	.	.	.	.	.	+	.	.	.	I	0.05
G	Cosm	3	3	0	P	*Pteridium aquilinum*	.	.	.	+	.	.	.	.	.	.	I	0.05

H	Cp	2	0	1	P	*Deschampsia flexuosa*	.	.	.	+	.	.	.	.	.	.	I	0.05
G	E	3.5	4	0	P	*Anemone nemorosa*	.	.	.	.	+	.	.	.	.	.	I	0.05
G	E	3.5	3	4	P	*Anemone ranunculoides*	.	.	.	.	+	.	.	.	.	.	I	0.05
H-Ch	MP	2.5	3	4	P	*Glechoma hirsuta*	.	.	.	.	+	.	.	.	.	.	I	0.05
G	Eua	2	3	4	D	*Polygonatum odoratum ssp.odoratum*	.	.	.	.	.	.	.	.	+	+	I	0.1
G	Ec	2.5	3	3	P	*Galium schultesi*	.	.	.	.	.	.	.	.	.	+	I	0.05
mPh	E	3	3	3	P	*Euonymus europaeus*	.	.	.	.	.	.	.	.	.	+	I	0.05
						Epilobietea angustifolii												
nPh	Cp	3	3	3	DP	*Rubus idaeus*	.	+	+	+	.	.	.	.	.	.	II	0.15
H	Cp	2.5	2	3	D	*Solidago virgaurea*	.	+	.	.	.	.	+	.	+	+	II	0.2
H	Atl-M	3	3	3	P	*Atropa bella- dona*	.	.	+	.	.	.	.	.	.	.	I	0.05
H	Eua	3	3	0	P	*Hypericum perforatum*	.	.	+	.	.	.	.	.	.	.	I	0.05
						Betulo- Adenostyletea												
H	E	2.5	2.5	2	DP	*Luzula luzuloides*	+	.	.	+	+	+	+	+	+	.	IV	0.35
H	Ec	4	2	4	P	*Gentiana asclepiadea*	.	.	+	.	.	.	+	.	+	.	II	0.15
G	E	3.5	2	3	P	*Doronicum austriacum*	.	.	.	.	.	.	+	.	+	+	II	0.15
G	Eua	4	0	0	P	*Petasites albus*	.	.	.	.	.	.	.	.	+	.	I	0.05
G	Alp-Carp-B	3.5	2	3.5	P	*Doronicum columnae*	.	+	.	.	.	.	.	.	.	.	I	0.05
G	Eua	4	2.5	4	DP	*Veratrum album*	.	.	+	.	.	+	.	.	.	.	I	0.1
						Vaccinio- Piceetea												
MPh	E	0	0	0	D	*Picea abies*	1	+	+	.	.	.	1	.	.	.	II	1.1
H	Cp	3.5	2	3	P	*Dryopteris cristata*	.	.	.	.	.	.	.	+	+	+	II	0.15
H	Ec	3.5	2.5	2	DP	*Luzula sylvatica*	.	.	.	.	.	.	.	.	+	.	I	0.05
Ch-nPh	Cp	0	2	1	D	*Vaccinium myrthillus*	.	.	.	.	.	.	.	+	.	.	I	0.05
						Variae Syntaxa												
H	M	3	2	5	D	*Primula veris ssp.columnae*	.	+	.	.	.	.	.	.	.	.	I	0.05
H	Eua	3	3	0	D	*Stachys officinalis*	.	.	+	.	.	.	.	.	.	.	I	0.05
G	Cp-Bo	3.5	3	4	P	*Polypodium vulgare*	.	.	.	.	.	.	+	.	.	+	I	0.1
H	Cosm	3	3	4	DPl	*Urtica dioica*	.	.	.	.	.	.	.	.	+	.	I	0.05

Location and date of surveys: 1 Piatra Grăitoare , 15.09.2018 GPS 462906, 223916; **2** Vârtop 16.09.2018 GPS 463036, 223936; **3** Băița 23.07.2019 GPS 463027, 223756,5; **4** Valea Criștior 26.07.2019 GPS 462513, 223713,9; **5** Dealul Runcului 26.07.2019 GPS 462537,7, 223757,9; **6** Vf. Lespedioara 27.09.2019 GPS 462053,2, 224158; **7** Pârâul Mare 27.07.2019 GPS 462156,9, 224044,7; **8** Valea Hălmăgel 27.07.2019 GPS 462125,8, 224301; **9** Valea Găina 07.08.2019 GPS 462013,2, 224219,6; **10** Valea Leucii 08.08.2019 GPS 462328,3, 223848,3.

The analysis of the association from the point of view of lifeforms (see Figure 1) highlights the fact that hemicryptophytes are in majority (47.19%), followed by geophytes (28.76%), phanerophytes (15.06%), camephytes (4.1%), therophytes (2.73%), and climbing plants (1.36%).

The spectrum of floristic elements (see Figure 2) highlights that the most representative species are Eurasian (38.35%), followed by European (20.54%), Central-European (13.69%), circumpolar (12.32%), cosmopolitan (5.47%), Atlantic-Mediterranean (4.1%), Alpine-Carpatho-Balkan (2.73%), Mediterranean (1.36%) and Pontic Mediterranean (1.36) species.

Regarding the ecological factors (see Figure 3), one may notice that in relation to moisture, the majority species are mesophilic (72.29%), followed at great distance by meso-hygrophilic and xeromesophilic species (with 12.31% each); in relation to air temperature, micro-mesothermals (56.15%), are followed by microthermals (27.38%) and eurythermic species (13.69%); with regard the chemical reaction of the soil, most species are acido-neutrophilic (35.61%), weakly acid-neutrophilic (31.50%), euriionic (20.54%), acidophilic (6.84%), strongly acidophilic and neutro-basiphilic (with 2.73% each).

Within the karyological spectrum (see Figure 4) the polyploid species are dominant (56.16%), followed by the diploid (30.13%) and diplo-polyploid (13.69%) species. The diploidy index has a value of 0.52.

Beech stands with *Festuca drymeja* are of economic importance, providing raw material and accessory products for the wood industry, the pulp and paper industry, the hospitability and food industry, but also for local communities. These forests are ecologically important in that they provide critical environmental services, anti-erosion, anchoring the soil through the root system, regulating watercourse flows and reducing surface runoff. One can find a small number of species of scientific value within this association, namely: *Lilium martagon, Cephalanthera longifolia, Platanthera bifolia, Sanicula europaea.*

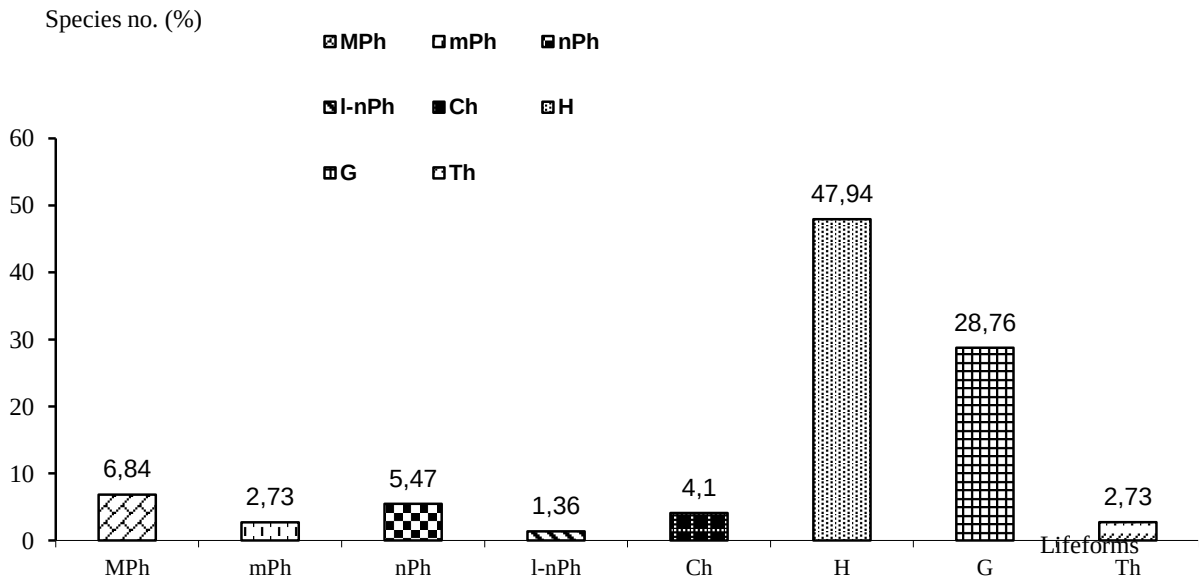

Figure 1. **The spectrum of bioforms in the association *Festuco drymejae – Fagetum***
Legend: MPh¬= Megaphanerophytes; mPh= Mesophanerophytes; nPh= Nanophanerophytes; l-nPh= Climbing plants; Ch= Camephytes; H= Hemicryptophytes; Th= Annual therophytes; G= Geophytes

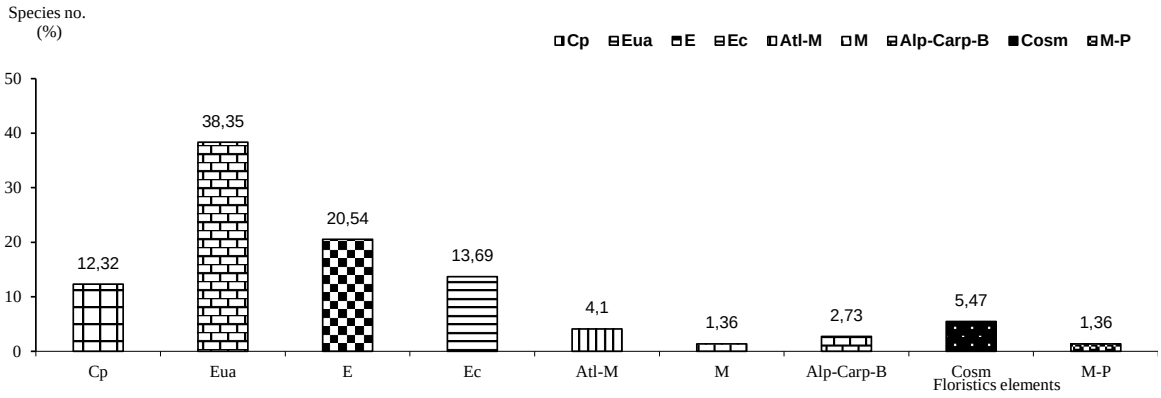

Figure 2. **The spectrum of floristic elements in the association *Festuco drymejae – Fagetum***
Legend: Cp= Circumpolar; Eua= Eurasian; E= European; Ec= Central European; Atl-M= Atlantic-Mediterranean; Alp-Carp-B=Alpino-Carpatho-Balkan; Cosm= Cosmopolitan, M= Mediterranean; M-P= Mediterranean-Pontic

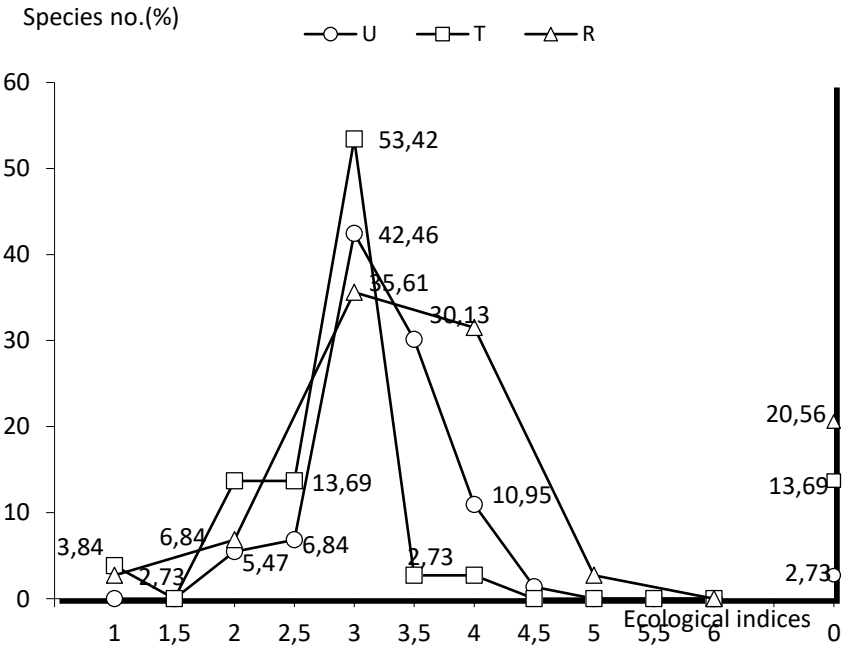

Figure 3**. Diagram of ecological indices for the association *Festuco drymejae – Fagetum***

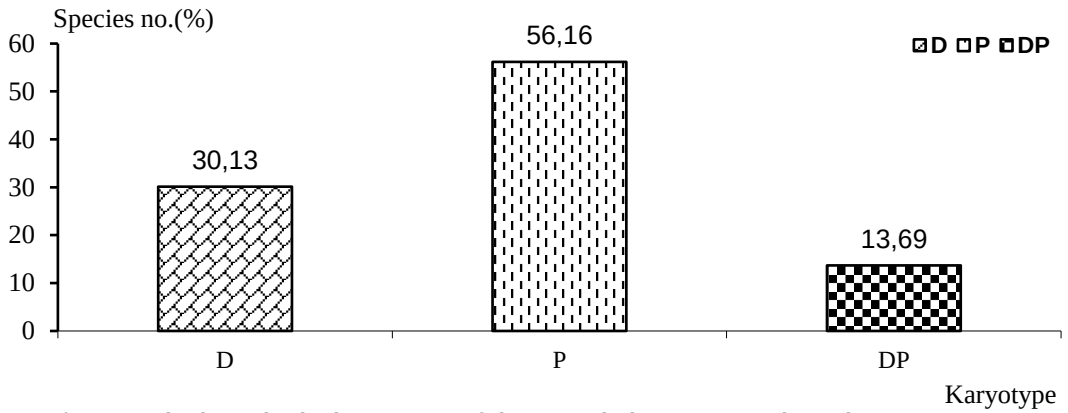

Figure 4. **The karyological spectrum of the association *Festuco drymejae – Fagetum***
Legend: D= Diploid; P= Polypoids; DP= Diplo-polyploids

CONCLUSIONS

1. The phytocenoses of these beech forests (*Fagus sylvatica*) with *Festuca drymeja* have a high conservation value, forming rare communities in sparsely distributed habitats.

2. In the spectrum of lifeforms, hemicryotophytes predominate (47.94%), followed at a distance by geophytes (28.76%), and phanerophytes (4.84%).

3. In terms of geographic area, the Eurasian species (38.35%) are predominant, followed by the European (20.54%), Central European (13.69%), and circumpolar (12.32%) species.

4. With regard the ecological indices, the most numerous elements, in relation to soil moisture are the mesophils (72.29%), in relation to the air temperature, the micro-mesothermals are predominant (56.15%), and in relation to the chemical reaction of the soil, the acid-neutrophils (31.50%) are dominant.

5. Analysis of chromosomal karyotypes highlights the dominance of polyploid species (56.16%), compared to diploid (30.13%) and diplo-polyploid (13.69%) ones.

REFERENCES

Bilz, M., Kell, SP., Maxted, N., Lansdown, RV., 2011. European Red List of Vascular Plants. Publicatoin Office of the European Union, Luxembourg.

Borhidi, A., 2003. Magyarország növénytársulássai, Akadémiai Kiadó, Budapest.

Borza, Al., Boşcaiu, N., 1965. Introduction to the study of the living soil cover. Romanian Academy Publishing House, 340 p.

Boșcaiu, N., Marossy , A., 1979. Aspects of vegetation from Cepelor Valley (Biharia Massif), Nymphaea, "Țării Crișurilor" Museum, Oradea. pp. 301-302.

Boşcaiu, N., Coldea, Gh., Horeanu, C., 1994.Red list of extinct, endangered, vulnerable and rare vascular plants from the flora of Romania. Ocrot. Nat. Med. Înconj., Bucharest, 38, 1:45-56.

Braun-Blanquet, J., Pavillard, G., 1928. Vocabulaire de sociologie végétale, ed.II, Imprimerie Roumegous & Dehan,Montpellier

Braun-Blanquet, J., 1964, Pflanzensoziologie, ed.III Springer-Verlag, Wien-New York.

Burescu, P., Toma, I., 2005. Manual of practical works of botany, Oradea University Press, Oradea, 590 p.

Chifu, T., (ed.), Irimia, I., Zamfirescu, O., 2014. The phytosociological diversity of Romania's vegetation, The European Institute, Iasi, vol. I+II+III.

Ciocârlan, V., 2009. Illustrated flora of Romania: Pteridophyta et Spermatophyta, Ceres Publishing House, Bucharest, 1141 p.

Coldea, Gh., Sanda, V., Popescu, A., Ştefan, N., 1997. Les associations végétales de Roumanie. Tome I: Les associations herbacées naturelles, Edit. Presa Universitară Clujeană, Cluj-Napoca, 261 p.

Cristea, V., Gafta, D., Pedrotti, F., 2004. Phytosociology. Cluj University Press, Cluj-Napoca, 396 p.

Dihoru, Gh., Negrean, G., 2009. Red Book of vascular plants from Romania. Romanian Academy, Publishing House, Bucharest, 630 p.

Majovszky, J., Murin, A., 1987. Karyotaxonomický prehl'ad flóry Slovenska, Veda, Bratislava, 436 p.

Marossy, A., 1973. Contributions to the knowledge of the flora of the Biharia I Massif, Nymphaea, "Țării Crișurilor" Museum, Oradea. p.p. 17-20.

Marossy, A., 1975. Contributions to the knowledge of the flora of the Biharia II Massif, Nymphaea, "Țării Crișurilor" Museum, Oradea. p.p. 83-86.

Meusel, H, Jäger, E.J., 1992. Vergleichende Chorologie der Zentraleuropäischen Flora. III, Gustav Fischer Verlag, Jena, 333 p.

Moore, D.M., 2009. Flora Europaea checklist and chromosome index, Cambridge Univ. Press., New York, 423 p.

Oberdorfer, E., 1992. Süddeutsche Pflanzen-gesellschaften, Teil IV: Wälder und Gebüsche 2, Stark berabeilete Auflage Texband, Gustav Fischer Verlag Viena, New York.

Oltean, M., Negrean, G., Popescu, A., Roman, N., Dihoru G., Sanda V., Mihăilescu, S., 1994. Red list of higher plants in Romania, Stud. Sint. Doc. Ecol., Romanian Academy, Bucharest, 1:1-52.