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THE PHYTOCOENOLOGY AND ECOLOGY OF EUROPEAN BEECH STANDS WITH *PHYLLITIS SCOLOPENDRIUM* FROM PADUREA CRAIULUI MOUNTAINS (NORTH-WESTERN ROMANIA)

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ABSTRACT. The European beech stands with *Phyllitis scolopendrium* are little known in Romania and have a sporadic distribution in massive Pădurea Craiului being quartered on the steep slopes of the canyons, gaps, narrow valleys, representing a type of intra-zone vegetation. These forests are subordinated to the association *Phyllitidi - Fagetum Vida* (1959) 1963, whose phytocoenosis are considered by us in terms of floral composition, ecological spectra of the type of life forms and floral elements, in terms of chart ecological indices (moisture, temperature and chemical reaction soil).

Keywords: phytosociology, *Phyllitis scolopendrium*, rare habitats, European beech stands, Northwestern Romania, Pădurea Craiului

INTRODUCTION

The Pădurea Craiului Mountains, west branch of the Apuseni Mountains, is characterized through an alternation of pedogenetic rocks, the main being the limestone with different faces and gluconitic coarse sandstone.

European beech stands are the main dominant forest form that represent 63% of the forest fund, is encountered at low altitudes (350 m) on slopes with northern exposition to the highest peaks (1000 m), where form pure or mixed beech stands.

The alternation of rock and soil types causes also an alternation of beech stands, the most representative being:

- high and medium productive beech stands, with mull humus on eumesobasic brown soil, typical rendzinic soil, hydric balanced, with *Symphytum cordatum*, *Cardamine glanduligera*;
- middle productive beech stands with mull-moder humus on brown luvic oligo-mesobasic and mesobasic soils hydric balanced with *Festuca drymeja*;
- middle and low productive beech stands with moder humus on luvic brown soils, brown acid, oligo-mesobasic, totally balanced with *Luzula luzuloides*;
- high and medium productive beech stands with mull humus on brown eu-mesobasic soils, hydric balanced with *Carpinus betulus*.

Scrutiny of the territory but allowed evidence of a new type of ecosystem - low productive beech stands with mull humus on brown eu-mesobasic litic and rendzinic soils, eubasic optimum hydric with *Phyllitis scolopendrium* (deer tongue), which can be treated as habitat type R4116 (Doniţă et al., 2005).

Descriptions of European beech stands with *Phyllitis scolopendrium* of Pădurea Craiului Mountains I found the work carried out by: (Burescu et al., 2002, 2003) and on those in Romania, the work carried out by (Borza, 1959) to Sebeş Valley, (Boşcaiu, 1971) in Ţarcu Mountains, Godeanu and Cerna, (Buiculescu, 1975) in Piatra Mare, (Coldea, 1990) in Maramureş County, (Vida, 1963) in Parâng Mountains, (Mihailescu, 1999) in Piatra Craiului Mountain, (Dihoru, 1975) in Siriu Mountains, (Tauber, 1982) in Plateau Lipovei. We present in this paper the results on floristic and ecologic composition of beech stands with *Phyllitis scolopendrium* of Pădurea Craiului Mountains in relation to ecological factors.

MATERIALS AND METHODS

In study of beech stands from Pădurea Craiului Mountains I used phyto-sociological research methods of Central European school of the principles and methodology developed by (Braun-Blanquet, 1926) and adapted by (Borza, 1934), (Borza, Boşcaiu, 1965) in particular vegetation cover in our country.

I made floristic-ecological analysis defining plant communities: association, sub-alliance, alliance, order, class and their ecology (synecology) as a first step in analyzing beech stands with *Phyllitis scolopendrium*, according to the principles developed by (Géhu, 1986).

The phytosociological survey including homogeneous floristic and physiognomic characteristics area were selected fragments of beech forest stands phytocoenosis with *Phyllitis scolopendrium*, their size is 400 m^2. Quantitative assessment of the participation of each plant species to describe the association Phyllitidi - Fagetum Vida (1959) 1963, was made with the index of abundance-dominance (AD) after evaluation system (Braun-Blanquet, Pavillard, 1928). Association table contains information on species within the floristic composition of the association, as life forms, floristic elements, ecological indices (moisture, temperature, chemical reaction of the soil), serial number of the survey, altitude (MSM), exposure, inclination (degrees), the consistency of forest stands (%) herbaceous layer cover (%) area (m^2), place and date of of reports. At the end of the table was entered and was calculated constant

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(K) whose classes ranging from I to V expresses the degree of coenotic fidelity of each species to environment of phytocoenosis of the association.

For completion of the ecological study of the association we have represented graphically the distribution of life forms, floristic elements and ecological indices.

RESULTS AND DISCUSSIONS

The phytocoenosis of Dacian beech stands with Phyllitis scolopendrium develops lower third of steep slopes (35-45°) with exhibition north (often other exhibitions) in the shadows with high humidity throughout the year - keys, narrow valleys, at altitudes between 400 -600 m as a type of intrazone vegetation within beech stands.

Tithonia limestone parent material is present on the surface as rocky, fixed or semimobile talus. Edaphic substrate consists of rendzinic lithosols sometimes cambic rendzines, 10-20 cm thick physiological, edaphic small volume, mid trophicity, reaction weak acid-neutral to slightly alkaline (pH = 6.0 - 7.2).

The specific floristic composition of the beech stands with *Phyllitis scolopendrium* from Pădurea Craiului Mountains and the edaphic-climatic factors characteristic to station where are developed such phytocoenosis are defining features sufficient to separate the association *Phyllitidi - Fagetum Vida* (1959) 1963 in the sub-alliance *Moehringio muscosae* - Acerenion Boşcaiu et al. 1982, the alliance *Symphyto cordati - Fagion Vida* in 1959, along with other associations with *Fagus sylvatica*.

The association *Phyllitidi – Fagetum* is tristratified and gathers a number of 82 mesophill, micro-mesotherm, low acid-neutral species (Table 1).

Tree layer is composed of *Fagus sylvatica, Acer pseudoplatanus, Acer platanoides, Acer campestre, Carpinus betulus, Fraxinus excelsior, Ulmus glabra, Prunus avium* achieving a constant between 0.7-1 and an average coverage of 75%. Beech crown diameter varied widely, from 2 to 12 m, are observed trend to develop permanent asymmetric with the largest crown to valley. This trend is caused by increased crown development to light, given to range of large trees on the northern slopes. Vertical structure is uneven, the variations of heights of various categories of trees are large, from 5 to 24 m (26 m), having even a multi-layer nature. The average height is 18.5 m at age 65 years, the productivity of forest stands is variable and falls into class IV production, but locally can be found stands of class V or class III.

Shrubs layer consists of *Corylus avellana, Cornus mas, Sambucus nigra, Staphylea pinnata, Euonymus latifolius, Daphne mezereum*, including lianas as *Hedera helix, Solanum dulcamara* coverage below 10%.

Herbaceous layer with an average coverage of 50% includes a large number of species of weak acid-neutrophyls (about 80), of which occupies an important place the indicator of rock, soil, moisture and trophycity.

Physiognomy of the association is given as *Fagus sylvatica* present in the layer of trees, species and dominant feature of media coverage of 65-70%, constant maximum (K = V) and the fern *Phyllitis scolopendrium* (deer tongue) of herbaceous layer, species characteristics and codominant with an average coverage of 25-30%, constant maximum (K = V).

The living soil cover with these plants found differential or recognition species which makes the association:

- to sub-alliance *Moehringio muscosae – Acerenion Acer pseudoplatanus, Acer platanoides, Ulmus glabra, Polystichum aculeatum, Lunaria rediviva, Moehringia muscosa, Geranium robertianum*,
- alliance *Symphyto cordati – Fagion Pulmonaria rubra, Symphytum cordatum, Cardamine glanduligera, Cardamine bulbifera, Atropa belladonna, Saxifraga cuneifolia, Gymnocarpium dryopteris, Festuca drymeja, Rubus hirtus*,
- to order *Fagetalia sylvaticae Asarum europaeum, Mercurialis perennis, Galium odoratum, Lamium galeobdolon, Oxalis acetosella, Circaea lutetiana, Sanicula europaea, Pulmonaria officinalis, Symphytum tuberosum, Euphorbia amygdaloides, Carpinus betulus, Daphne mezereum, Arum maculatum* etc.,
- to class *Querco – Fagetea, Dryopteris filix-mas, Athyrium filix-femina, Hedera helix, Mycelis muralis, Acer campestre, Fraxinus excelsior, Corylus avellana, Cornus mas, Staphylea pinnata, Evonymus latifolius, Polygonatum odoratum, Carex digitata, Salvia glutinosa, Viola reichenbachiana, Hepatica nobilis, Melittis melissophylum, Primula veris ssp. columnae* etc.

On the edge of association occurs a number of 7 saxicola and transgressive species of class *Asplenietea trichomanis: Polypodium vulgare, Asplenium trichomanis ssp quadrivalens, Asplenium viride, Asplenium ruta-muraria, Ceterach officinarum, Woodsia ilevensis, Poa nemoralis var. montana*.

Analyzing the composition of beech stands with *Phyllitis scolopendrium* after major ecological factors (Figure 1), we find that they fall under mesophyll deciduous forest group (45.1%) characteristic of a habitat with soil hydric balanced, with a moist atmosphere, micro-mesothermal (63.4%) showing a temperate-continental, which prefers an edaphic substrate (rock, soil) with the reaction of weak acid-neutrophyls (36.6%) to acid-neutrophyls (32.9%).

The spectrum of life forms (Fig. 2), phanerophytes representing woody species are quantitatively dominant, while numerically the hemicryptophytes have the largest percentage (52.4%), meaning natural disturbances, uprooting, tearing and windfalls and

snowfalls, followed by geophytes (18.2%), which go through the cycle of vegetation in a very short period of time.

Floristic elements spectrum (Fig. 3) shows the numerical dominance of Eurasian species (25.6%), adapted to a temperate continental dry climate, followed closely by the European species (21.9%), showing a moderate climate tempered, by the Central European species (20.7 %), temperate-humid climate. Central European species with the Euroepan species have the largest percentage (42.6%) was dominant from the Eurasian and provide us such information about cold and wet nature of the site.

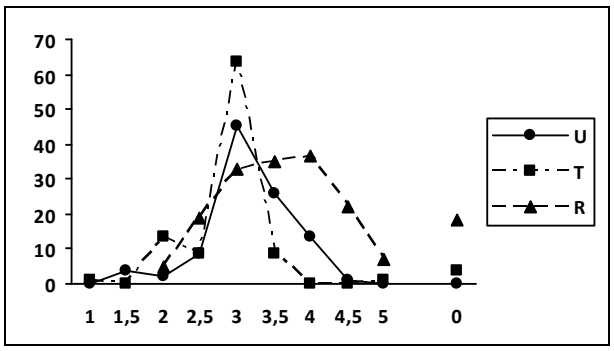

Fig. 1 Diagram of ecological factors of ass. *Phyllitidi – Fagetum Vida* (1959) 1963

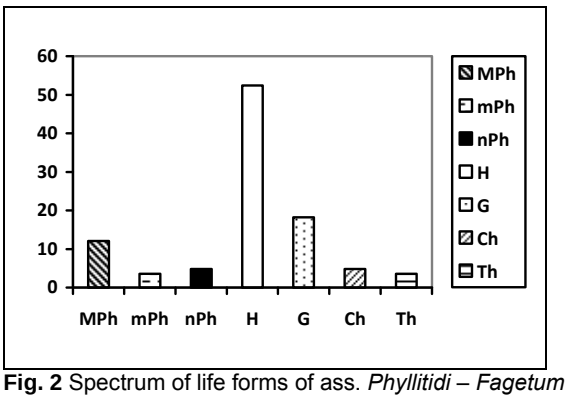

Fig. 2 Spectrum of life forms of ass. *Phyllitidi – Fagetum Vida* (1959) 1963

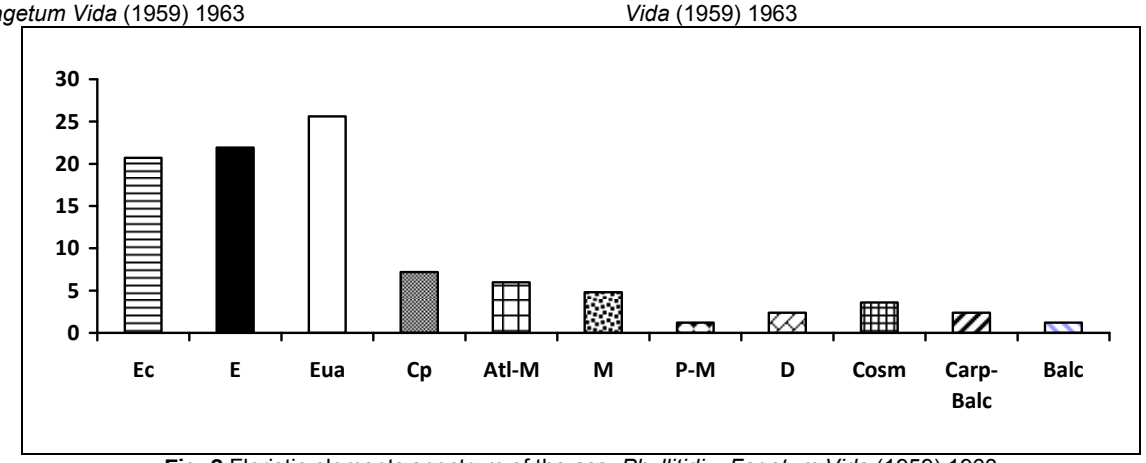

Fig. 3 Floristic elements spectrum of the ass. *Phyllitidi – Fagetum Vida* (1959) 1963

Association presented a stable equilibrium because naturally any of the dominant species of tree layer and herbaceous layer do not tend to replace each other. It is necessary to maintain the natural state of these forests, because the particular nature of the stations they occupy, fall in group priority functions of protection forests, forests of group I subgroup 1.2a, 1.5j, with an important ecological role in keeping surface soil layer, by adjusting the fluid balance, in biodiversity conservation of calciphylous species some of which are rare, endangered, vulnerable.

To perform these functions, the current beech stands with middle ages would have led to an uneven structure as closer to the structure of forest gardening. The economical aspect, the association has of particular interest in high quality wood material provided by the dominant species.

Phytocoenosis belonging association *Phyllitidi - Fagetum* with a similar floristic composition has been described in several regions of the country: (Borza, 1959) Sebeş Valley (Alba county), (Boşcaiu, 1971) Cerna Mountains, (Buiculescu, 1975) of Piatra Mare, (Coldea, 1972) Plopiş Mountains (Bihor county), (Vida, 1963) in Parâng Mountains, (Ardelean, 1999) from the valley Crişul Alb (Arad county).

Association described the limestone slopes of Mount Vulcan in the upper basin of Crişul Alb river (Arad county) is similar in parts but different in others and described by us in Pădurea Craiului Mountains (Bihor county), as follows:

a) phytocoenosis of beech stands with Phyllitis scolopendrium from Valley Crişul Alb dominates the type of life form hemicryptophytes (50%) followed by geophytes (23%), the floristic elements have the highest share Eurasian species (26%), followed by European (24%) and Central European (18%). In the light of ecological factors (humidity, temperature and soil chemical reaction), the phytocoenosis are mesophyll (67%), micro-mesothermal (69%), acid-neutrophil (40%). The fern Phyllitis scolopendrium cover is weak, insignificant, only 2.3% and a consistently high (K = IV).

Fig. 4 *Phyllitidi – Fagetum Vida* (1959) 1963, on rendzinic limestone of Vida Valley, Pădurea Craiului Mountains (original photo)

b) phytocoenosis of beech stands with *Phyllitis scolopendrium* of massive Pădurea Craiului (Bihor County) predominates such as organic whole hemicryptophytes (52.4%), two percent higher, followed by geophytes (18.2%), five percent lower. The floristic elements dominate the Eurasian species (25.6%) followed by European (18%) with less than six percent and Central European (17%). In terms of ecological factors, the phytocoenosis of beech stands with *Phyllitis scolopendrium* of Pădurea Craiului are mesophyll (45.1%), with twenty-two percent of small, micro-mesothermal (63.4%), three percent lower, weak acid-neutrophil (36.6 %). Fern *Phyllitis scolopendrium* made media coverage of 25%, with twenty-two percent higher, and a maximum constant (K = V).

CONCLUSIONS

The beech stands with *Phyllitis scolopendrium* represent an natural forest ecosystem is a natural life survives in extreme conditions on rocky slopes strongly inclined (38-48°), with fixed or semi-mobile talus where naturally regenerated from seedlings burdensome conditions.

The special character of the sites are developed, rocky slopes and tales with very steep (38-48°), the European beech stands with *Phyllitis scolopendrium* fall in group of priority function forest of anti-erosion protection and on adjustment of hydric balance.

Beech stands with *Phyllitis scolopendrium* are part of partially degraded forest ecosystems belonging to a rare habitat type (Nature 2000, R4116), which occupies under 5% of forest fund areas are concentrated a large number of species - rich biodiversity, some are rare plants, endangered, vulnerable, endemic, relicts, natural monuments, listed red, reasons enough to be preserved.

The beech stands of massive Pădurea Craiului suffered in recent years due to a degradation anthropogenic influences, the violence in the exploitation of timber by traders who have caused great damage.

Fig. 5 *Phyllitidi – Fagetum Vida* (1959) 1963, on steep slopes with northern exhibition, Pădurea Craiului Mountains (original photo)

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Table 1

Phyllitidi – Fagetum Vida (1959) 1963

					Survey	1	2	3	4	5	6	7	8	9	10	11	K
					Altitude (m.s.m)	420	450	450	460	400	450	480	550	520	600	500	
					Exposure	NE	NV	N	NV	SE	N	NE	E	V	SV	E	
					Inclination (°)	35	38	45	30	35	35	45	40	35	35	40	
					Consistency	0.9	0.8	1	1	0.7	0.7	1	0.7	0.7	0.7	0.9	
					Coverage (%)	65	60	60	40	50	40	25	35	70	25	70	
L.f.	F.e.	U	T	R	Area (m^2)	400	400	400	400	400	400	400	400	400	400	400	
MPh	Ec	3	2	0	*As.Fagus sylvatica*	4	4	4	5	4	4	5	4	4	4	4	V
G	Cp	3.5	3	5	*As.Phyllitis scolopendrium*	3	3	2	2	3	2	2	2	3	1	2	V
					Moehringio muscosae -Acerenion												
MPh	Ec-M	3.5	3	3	*Acer pseudoplatanus*	+	1	1	.	.	.	+	.	+	2	+	III
MPh	E	4	3	3	*Ulmus glabra*	+	+	.	.	.	.	.	.	+	+	+	II
H	Eua	3.5	0	4	*Polystichum aculeatum*	+	+	+	+	+	.	.	.	.	.	.	III
Th	Eua	3.5	3	3	*Geranium robertianum*	.	+	+	.	+	+	.	.	+	+	+	III
H-G	Ec-M	4	3	4	*Lunaeria rediviva*	.	.	.	.	.	.	.	+	2	1	2	II
H	Ec	4	2	5	*Moehringia muscosa*	.	.	.	.	.	.	+	+	.	.	+	I
MPh	Eua	3	3	3	*Acer platanoides*	.	.	.	.	.	.	.	.	.	+	+	I
					Symphyto cordati - Fagion												
H	Eua	3.5	3	3	*Actaea spicata*	.	.	.	.	.	.	.	.	.	.	+	-
nPh	E	3	2.5	2	*Rubus hirtus*	.	+	+	+	+	+	+	.	.	.	+	III
H	Carp-Balc	3.5	2	3	*Pulmonaria rubra*	.	+	+	.	.	.	+	.	.	.	.	II
H	Atl-M	3	3	3	*Atropa belladonna*	.	+	+	.	.	.	.	.	.	+	.	II
Ch	Ec	3.5	2	0	*Saxifraga cuneifolia*	.	.	+	.	.	.	.	.	.	.	.	I
H	D	3	2	3	*Symphytum cordatum*	.	1	+	.	.	.	.	.	.	.	+	I
G	Cp	3	2.5	2	*Gymnocarpium dryopteris*	.	.	+	.	.	.	.	.	.	.	.	I
G	Ec	3	3	4	*Cardamine bulbifera*	.	+	+	.	.	.	.	.	.	.	.	I
H-G	M	4	2	3	*Festuca drymeja*	+	.	.	.	.	.	.	.	.	.	+	I
H	Atl-M	3	3	3	*Primula acaulis*	.	.	.	.	.	.	.	.	.	+	.	I
G	Carp (End)	4	2.5	4	*Cardamine glanduligera*	.	.	.	.	.	.	.	.	.	.	+	I
					Fagetalia sylvaticae												
G-H	Eua	3.5	3	4	*Asarum europaeum*	+	1	1	+	1	+	+	+	+	+	+	V
H-G	E	3.5	3	5	*Mercurialis perennis*	1	+	+	+	+	.	+	+	+	+	+	V
G	Eua	3	3	3	*Galium odoratum*	+	+	.	+	1	+	+	1	+	+	1	V
Gh-H	Ec	3.5	3	4	*Lamium galeobdolon*	1	+	+	1	+	.	.	+	1	+	1	IV
H-G	Cp	4	3	3	*Oxalis acetosella*	.	+	+	+	.	.	.	+	+	.	.	III
G	Eua	3.5	3	4	*Circaea lutetiana*	.	.	+	+	+	+	.	+	+	.	+	III
MPh	Ec	3	2.5	0	*Carpinus betulus*	2	+	2	.	.	.	.	1	1	+	2	III
H	Eua-M	3.5	3	3	*Sanicula europaea*	+	+	.	+	.	.	.	+	+	.	+	III
H	Ec	3.5	3	3	*Pulmonaria officinalis*	+	.	.	.	+	+	.	.	.	.	.	II

Single survey were identified: Cephalaria levigata (1); Verbascum phlomoides (1); Gymnocarpium robertianum (3), Chelidonium majus (3), Tamus communis (4), Huperzia selago (7), Galium molugo (10), Gentiana asclepiadea (11).

Place and date: 1. Pârâul Strivinosu Lazuri de Roşia, 23.08.2008; 2. Valea Toplicioara Lazuri de Roşia, 21.05.2000; 3. Valea Şoimuş Lazuri de Roşia, 21.05.2000; 4. Pârâul Farcului, com.Roşia, 23.08.2008; 5. Valea Ştezelor com.Roşia, 31.08.2008; 6. Valea Cuţii com.Roşia, 31.08.2008; 7. Valea Fiului com.Roşia, 31.08.2008; 8. Izbucul Văii Vida, com.Dobreşti, 24.08.2007; 9. Pârâul Topliţa-Vida, com.Dobreşti, 25.08.2007; 10. Stanul Roşu pe Vida, com.Dobreşti, 25.08.2007; 11. Valea Vida la Tunel, com.Dobreşti, 24.08.2007.

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