PHYTOCOENOLOGICAL STUDY OF ROCKY VEGETATION FROM CODRU-MOMA MOUNTAINS BASED ON ECOLOGICAL INDICES

Păşcuţ Călin Gheorghe*

* University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048, Oradea, Romania, e-mail: pascutcalin@yahoo.com

Abstract

In this paper the ecological factors for the rocky associations from Codru-Moma Mountains are studied (humidity, temperature, chemical reaction of soil). The study was done during 2008-2018, a number of 5 rocky associations being identified: Asplenietum rutae-murariae-trichomanis R. Tüxen 1937 (25 relevées), Asplenio quadrivalenti-Poëtum nemoralis Soó ex Gergely et al. 1966 (17 relevées), Asplenietum septentrionali-adianti-nigri Oberdorfer 1938 (9 relevées), Asplenio trichomani-Poëtum nemoralis Boşcaiu 1971 (25 relevées), Ctenidio-Polypodietum Jurko et Peciar 1963 (25 relevées).

In Codru-Moma Mountains the phytocoenoses of these associations have been identified at altitudes of 330-950 m, on siliceous or calcareous rocks, with large inclination (30-90º) and shaded exposition (N, E, V, NV, NE), along some valleys and streams on the edge of hornbeam and beech forests. Vegetation covers 25-100%, and due to the fact that on these cliffs humidity is high all year round, a series of bryophytes appear (1-40%).

Key words: ecological factors, humidity, temperature, chemical reaction of soil, relevées

INTRODUCTION

The rocky phytocoenoses represent the pioneer vegetation that develops in the cracks of calcareous and siliceous rocks from Codru-Moma Mountains. Due to the nature of the substrate and the restrictive climatic conditions, the floristic composition of these associations is characterized by an abundance of species of *Querco-Fagetea, Festuco-Brometea, Rhamno-Prunetea* classes.

The main plant rocky associations identified in the Codru-Moma Mountains and analyzed in this paper from the ecological point of view are:

Asplenietea trichomanis Class (Br.-Bl. in Meier et Br.-Bl. 1934) Oberdorfer 1977

Tortulo-Cymbalarietalia order Segal 1969

Cymbalario-Asplenion alliance Segal 1969 em. Mucina 1993

1. *Asplenietum rutae-murariae-trichomanis* association R. Tüxen 1937

Cystopteridion alliance Richard 1972

2. *Asplenio quadrivalenti-Poëtum nemoralis* association Soó ex Gergely et al. 1966

Androsacetalia vandelli order Br.-Bl. in Maier et Br.-Bl. 1934

Asplenion septentrionalis alliance Oberdorfer 1938

3. *Asplenietum septentrionali-adianti-nigri* association Oberdorfer 1938

4. *Asplenio trichomani-Poëtum nemoralis* association Boşcaiu 1971

Hypno-Polypodion alliance Mucina 1993

5. *Ctenidio-Polypodietum* association Jurko et Peciar 1963

Older studies related to the rocky vegetation from Codru-Moma Mountains were made by Paucă (1941). More recent publications relating to the rocky vegetation from Codru-Moma Mountains were made by Păşcuţ (2010, 2013), Burescu and Păşcuţ (2010).

In our country and in Europe, these rocky associations were studied by Pascal and Mititelu (1971), Pop et al., (2002), Raţiu et al., (1984), Ştefan et al., (1997), Sârbu et al., (1997), Chifu et al., (2006), Chifu et al., (2014), Oprea and Sîrbu (2009), Raţiu and Gergely (1976), Schneider-Binder (1968, 1969, 1972), Mihăilescu (2001), Karácsonyi, (2011), Groza, (2008), Niculescu (2006), Stancu (2005), Răduţoiu (2006), Drăgulescu (1985, 1988), Diaconescu (1973), Alexiu (1998), Peia, (1978), Kolbek et al., (2015), Pott (1995), Borhidi (2003), Pignatti and Pignatti (2014), Świerkosz (2004).

MATERIAL AND METHOD

For the study of the identified associations we used ecological spectra that take into account the presence of the species in the association, as well as humidity, temperature and chemical reaction of soil for each species (Sanda et al., 1983). The phytocoenological description of the associations is followed by comparative analysis in order to outline the requirements of each association on ecological factors.

In the table constancy (K) is mentioned for each identified species. The constancy (K) outlines the general presence of a species in all the relevées analysed, belonging to the same type of phytocoenose (Cristea et al., 2004).

In the reports of the relevées information regarding altitude, herbaceous layer coverage, bryophytes layer coverage, exposition and slope was introduced.

Information concerning life forms, floristic elements and ecological indices is given based on Sanda et al., (1983), Cristea et al., (2004).

Nomenclature adopted for the identified species is in accordance with the work developed by the Ciocârlan (2009) şi Sârbu et al., (2013).

RESULTS AND DISCUSSION

The rocky associations identified in the Codru-Moma Mountains are presented as follows:

1. ***Asplenietum rutae-murariae-trichomanis*** association R. Tüxen 1937

The phytocoenose of *Asplenietum rutae-murariae-trichomanis* association (figure 1), develops in the form of clumps among the cracks and on shelves of heavily skewed limestone rocks (30-90º), mainly with north, northwest or northeast exposition. It is widespread on the rocks along the intermountain valleys and creeks at altitudes of 400-680 m.

Thanks to the nordic exhibition of the rocks and the inclusion of these phytocoenoses in beech forests, a shaded microclimate with moderate humidity almost all year round has been created, as well as lower temperature in summer. This has allowed the installation of bryophytes of the genus *Ctenidium* and *Syntrichia* within these phytocoenoses.

Considering life forms, the hemycryptophytes (59.37%) dominate, followed by terophytes (17.19%) and chamaephytes (10.94%).

The most numerous floristic elements are eurasian (35.94%), followed by european (20.31%), central-european (15.63%) and mediterranean (7.8%) ones.

2. ***Asplenio quadrivalenti-Poëtum nemoralis*** association Soó ex Gergely et al. 1966

The association phytocoenoses vegetate on shaded limestone rocks, with high slope (40-90º), located at altitudes of 410-800 m, set on shaded slopes (N, NV, NE). The physiognomy of the association is given by the two edifying species *Asplenium trichomanes* ssp. *quadrivalens* and *Poa nemoralis*, in terms of codominance.

The life forms are dominated by hemycryptophytes (52.38%), followed by phanerophytes (23.8%), geophytes and terophytes (11.91%) having an equal share.

The floristic elements show the predominance in the association of the eurasian species (38.09%), followed by european (23.81%), central-european (16.67%), cosmopolitan (9.53%) and south european (4.76%) ones.

In this association the bryophytes layer consisting of *Ctenidium molluscum* and *Marchantia polymorpha* plays an important role in maintaining moisture.

3. ***Asplenietum septentrionali-adianti-nigri*** association Oberdorfer 1938

In Codru-Moma Mountains the phytocoenoses of this association (figure 2), have been identified at altitudes of 350-590 m, on siliceous rocks

with great slope (40-80º), along some valleys and streams on the edge of hornbeam and beech forests. They develop on superficial soil, poor in organic substances and with a low acid neutrophile PH.

The life forms outline the presence of a large number of hemycryptophyte species (75%), followed by chamaephytes (10.71%) and nanophanerophytes (7.14%).

Floristic elements with the largest share in the association are the eurasians (42.86%), followed by european species (14.29%), central-european species (10.71%), cosmopolitan (10.71%) and circumpolar (10.71%) ones.

On these rocks there is high humidity all year round, demonstrated by the presence of *Ctenidium molluscum* species.

Fig. 1. *Asplenietum rutae-murariae-trichomanis* (Râposu Brook, Bihor County)

Fig. 2. *Asplenietum septentrionali-adianti-nigri*, (Briheni Valley, Bihor County)

4. *Asplenio trichomani-Poëtum nemoralis* association Boşcaiu 1971

It is an association found on siliceous rocks, with great slope (30-90º), at altitudes between 350-945 m. The phytocoenoses of this association (figure 3), prefer the rocks in shady valleys, located on slopes with northern and north-western exposition.

Considering life forms hemycryptophytes (52.38%) have the highest share, followed by the phanerophytes (25.39%), terophytes (12.7%) and geophytes (9.52%).

Among the floristic elements in the phytocoenoses analyzed the eurasian species (34.92%) dominate, supplemented by european (19.05%), central-european (17.46%) and south european (9.53%) ones.

Bryophytes layer is well represented, consisting of *Ctenidium molluscum, Hypnum cupressiforme, Marchantia polymorpha, Polytrichum commune*.

An important feature is a large fluctuation of coincidental species generated by the variability of vegetation conditions.

5. *Ctenidio-Polypodietum* association Jurko et Peciar 1963

The *Ctenidio-Polypodietum* phytocoenoses (figure 4), develop in the cracks and on shaded rocks, on lower hills and up to the top of Codru-Moma Mountains, at altitudes of 330-1000 m, on terrains with a shady exposition (N, NV, NE) and high slope (30-90º). Humidity is the determining factor, the association being mainly found on the lower third of steep and shady slopes, near the mountain valleys and creeks.

In the case of life forms one can observe the presence of the large number of hemycryptophyte species (57.81%), followed by phanerophytes (17.19%), geophytes (12.5%) and terophytes (12.5%).

Considering floristic elements, you can see the share of eurasian species (26.56%), european ones (23.44%), followed by central-european (15.62%), cosmopolitan (12.5%) and south european (9.37%) species.

Fig. 3. *Asplenio trichomani-Poëtum nemoralis* (Urviş Valley, Arad County)

Fig. 4. *Ctenidio-Polypodietum* (Finiş Valley, Bihor County)

The following table presents in detail the floristic composition of the associations identified, as well as the constancy (K) for each species.

Table 1

Indices of species constancy for the analyzed associations

The number of the association	1	2	3	4	5
Altitude (m.s.m.)	400-680	410-800	350-590	350-945	330-950
The coverage of vegetation layer (%)	25-80	30-85	40-80	40-80	50-100
The coverage of bryophytes layer (%)	1-25	5-40	5-20	1-25	1
Exposition	N, NE, NV	N, NE, NV, E	N, V, NV	N, V, E, NV, NE	N, V, NE, NV
Slope (º)	30-90	40-90	80-90	30-90	30-90
Asplenietea trichomanis					
Asplenium trichomanes ssp. *quadrivalens*	V	V	·	·	II
Asplenium trichomanes ssp. *trichomanes*	·	·	V	V	III
Asplenium ruta-muraria	V	I	·	·	I

0	*1*	*2*	*3*	*4*	*5*
Asplenium septentrionale	·	·	V	I	I
Asplenium adiantum-nigrum	·	·	V	I	I
Poa nemoralis	II	V	IV	V	III
Sedum maximum	II	III	V	IV	IV
Polypodium vulgare	II	II	II	IV	V
Valeriana tripteris	II	II	·	I	I
Cystopteris fragilis	I	II	·	I	I
Sile nutans ssp. *dubia*	·	·	II	·	·
Cardaminopsis arenosa	I	I		I	I
Asplenium adulterinum	·	I	I	·	I
Sedum hispanicum	I	·	·	·	·
Calamagrostis arundinacea	·	·	·	·	I
Ceterach officinarum	·	·	·	·	I
Festuco-Brometea	·	·	·	·	·
Teucrium chamaedrys	II	·	III	·	·
Sedum acre	I	·	III	·	·
Thymus glabrescens	I	·	III	·	·
Euphorbia cyparissias	I	·	II	·	·
Hypericum perforatum	I	·	II	·	·
Potentilla argentea	I	·	II	·	·
Achillea collina	I	·	·	·	·
Agrimonia eupatoria	I	·	·	·	·
Asperula cynanchica	I	·	·	·	·
Brachypodium pinnatum	I	·	·	·	·
Centaurea biebersteinii	I	·	·	·	·
Dianthus carthusianorum	I	·	·	·	·
Festuca valesiaca	I	·	·	·	·
Fragaria viridis	I	·	·	·	·
Geranium pusillum	I	·	·	·	·
Poa compressa	I	·	·	·	·
Potentilla arenaria	I	·	·	·	·
Sanguisorba minor	I	·	·	·	·
Sedum sexangulare	I	·	·	·	·
Stachys germanica	I	·	·	·	·
Teucrium montanum	I	·	·	·	·
Thymus comosus	I	·	·	·	·
Thymus pannonicus ssp. *pannonicus*	I	·	·	·	·
Trifolium arvense	I	·	·	·	·
Viola arvensis	I	·	·	·	·
Vincetoxicum hirundinaria	I	·	·	·	·
Querco-Fagetea					
Geranium robertianum	II	III	II	III	IV
Lamium galeobdolon	II	III	·	III	IV
Asplenium scolopendrium	III	IV	·	II	II
Rubus hirtus	·	II	·	IV	III
Mycelis muralis	II	III	II	III	III
Moehringia muscosa	II	III	II	II	II
Dryopteris filix-mas	I	I	II	III	II
Hedera helix	III	II	·	I	II
Cruciata glabra	·	·	III	I	·
Campanula persicifolia	II	I	II	II	II
Asarum europaeum	I	I	·	II	II
Oxalis acetosella	I	·	·	II	II
Galium schultesii	I	II	·	I	I
Polygonatum odoratum	·	I	·	I	II
Athyrium filix-femina	·	·	·	I	II
Galium odoratum	·	·	·	I	II
Luzula luzuloides	·	·	·	I	II
Polystichum aculeatum	·	II	·	·	I

0	*1*	*2*	*3*	*4*	*5*
Clinopodium vulgare	·	·	II	·	·
Campanula rapunculoides	I	I	·	I	I
Moehringia trinervia	I	I	·	I	I
Daphne mezereum	I	I	·	I	·
Euonymus latifolius	·	I	·	I	I
Acer pseudoplatanus	·	·	·	I	I
Alliaria petiolata	·		·	I	I
Carpinus betulus	·	·	·	I	I
Hepatica nobilis	I	I	·	·	·
Lamium maculatum ssp. *maculatum*	·	·	·	I	I
Polystichum setiferum	·	·	·	I	I
Stellaria holostea	·	·	·	I	I
Brachypodium sylvaticum	·	·	·	I	·
Carex pilosa	·	·	·	·	I
Dentaria bulbifera	·	·	·	·	I
Fagus sylvatica	·	I	·	·	·
Festuca drymeja	·	·	·	·	I
Glechoma hirsuta	·	·	·	I	·
Pulmonaria officinalis	·	·	·	·	I
Sanicula europaea	·	·	·	I	·
Tilia platyphyllos	·	·	·	·	I
Viola reichenbachiana	·	·	·	I	·
Rhamno-Prunetea					
Sambucus nigra	I	·	·	II	III
Corylus avellana	·	I	·	I	II
Galeopsis speciosa	·	I	·	I	II
Clematis vitalba	·	I	·	I	·
Acer campestre	·	·	·	I	I
Cornus sanguinea	·	·	·	I	·
Crataegus monogyna	·	·	·	I	·
Evonymus europaeus	·	·	·	I	·
Salix capraea	·	·	·	I	·
Ulmus glabra	·	·	·	·	I
Verbascum nigrum	·	·	·	I	·
Variae Syntaxa					
Salvia glutinosa	II	I	II	I	III
Fragaria vesca	·	I	III	I	·
Doronicum austriacum	II	I	·	·	II
Galium album	II	I	·	I	I
Chamaecytisus hirsutus ssp. *leucotrichus*	·	·	II	I	·
Chelidonium majus	·	·	·	I	II
Genista ovata	·	·	II	·	·
Arabis turrita	I	·	·	I	I
Melampyrum bihariense	·	I	·	I	I
Tamus communis	·	·	·	I	I
Urtica dioica	·	·	·	I	I
Vincetoxicum hirundinaria	·	I	·	·	I
Achillea millefolium	I	·	·	·	·
Cytisus nigricans	·	·	·	I	·
Dianthus spiculifolius	I	·	·	·	·
Festuca pallens	·	·	·	·	I
Galium mollugo	I	·	·	·	·
Gentiana asclepiadea	·	·	·	I	·
Hieracium pilosella	I	·	·	·	·
Hieracium umbellatum	·	·	·	·	I
Medicago lupulina	I	·	·	·	·
Melittis melissophyllum	·	·	·	·	I
Peucedanum longifolium	I	·	·	·	·

0	*1*	*2*	*3*	*4*	*5*
Primula elatior ssp. *leucophylla*	I	·	·	·	·
Rosa canina	I	·	·	·	·
Sedum cepaea	·	·	·	·	I
Sambucus nigra	·	I	·	·	·
Solidago virgaurea	·	·	·	I	·
Valeriana officinalis	·	I	·	·	·
Verbascum phlomoides	I	·	·	·	·
Veronica chamaedrys	·	·	·	I	·
Bryophyta					
Ctenidium molluscum	III	IV	IV	II	V
Marchantia polymorpha	·	I	·	I	I
Hypnum cupressiforme	·	·	·	I	·
Polytrichum commune	·	·	·	I	·
Syntrichia ruralis var. *calcicola*	I	·	·	·	·

Place and date of relevées: 1 - *Asplenietum rutae-murariae-trichomanis* association, Brook of Râposu (7 relevées), Morilor Valley (5 relevées), Ormanu Valley (2 relevées), Briheni Valley (2 relevées), Şopotesei Valley, Câmp Moţi village (2 relevées), Ţarinii Valley, Bănişoara Sfâraş, Ponoare Meadow, Crişului Văratec Valley (1 relevé) (Bihor County), Moneasa Valley (1 relevé) (Arad County). 2 - *Asplenio quadrivalenti-Poëtum nemoralis* association, Brook of Râposu (2 relevées), Tărcăiţa Valley (5 relevées), Şaua Bălănescu to Summit of Tisa, Moara Dracului-Briheni village, Şopotesei Valley (4 relevées), Rock of Şopotesei, Ponoare Meadow, Şesuţa Valley, Summit of Caprei (1 relevé)(Bihor County). 3 - *Asplenietum septentrionali-adianti-nigri* association, Mic Valley (4 relevées), Briheni Valley (5 relevées) (Bihor County). 4 - *Asplenio trichomani-Poëtum nemoralis* association, Şerbanu Valley, Mic Valley, Cusuiuş Valley (2 relevées), Briheni Valley, Zărzag Valley (3 relevées), Crişului Văratec Valley, Caselor Hill, Toaca Hill, Tărcăiţa Valley (Bihor County), Urviş Valley (3 relevées), Archişel Valley, Boroaia Valley (3 relevées), Clit Valley (3 relevées), Zugău Valley, Summit of Izoiu Mic, Râului Valley, Hăşmaş Valley (Arad County). 5 - *Ctenidio-Polypodietum* association, Brook of Râposu, Ormanu Valley, Şerban Valley, Morilor Valley - La Stan, Şoim Valley, Moşcoru Valley, Cusuiuş Valley, Zărzag Valley, Pont Valley, Finiş Valley, Moara Dracului – Briheni village, Mic Valley, Crişului Văratec Valley, Mare Hill (1 relevé) (Bihor County), Urviş Valley, Clit Valley, Hăşmaş Valley, Moneasa Valley, Boroaia Valley, Summit of Izoiu Mic, Summit of Osoiu Mare, Megheş Valley - Piatra Mică, Brook of Osoi, Summit of Merişoara, Râului Valley, Summit of Moma (1 relevé) (Arad County).

In the following table there are shown the values of ecological indices (humidity, temperature, chemical reaction of soil), for the rocky associations studied.

Table 2

The distribution of the species on ecological categories depending on humidity (U), temperature (T), chemical reaction of soil (R)

Asociations / Ecological categories(%)		**1**	**1,5**	**2**	**2,5**	**3**	**3,5**	**4**	**4,5**	**5**	**5,5**	**6**	**0**
As. 1	U	3,12	7,81	28,12	15,63	25	12,5	6,25	-	-	-	-	1,56
	T	-	-	4,69	3,12	50	14,06	15,62	-	1,56	-	-	10,94
	R	-	-	1,56	-	25	-	43,75	-	6,25	-	-	23,44
As. 2	U	-	2,38	7,14	11,91	47,62	21,43	7,14	-	-	-	-	2,38
	T	-	-	9,52	7,14	66,67	2,38	2,38	-	-	-	-	11,91
	R	-	-	-	-	35,71	-	35,71	-	4,76	-	-	23,81
As. 3	U	3,57	-	28,57	14,29	32,14	10,71	7,14	-	-	-	-	3,57
	T	-	-	7,14	7,14	64,29	7,14	7,14	-	-	-	-	7,14
	R	3,57	-	10,71	-	21,43	-	35,71	-	-	-	-	28,57
As. 4	U	1,59	-	7,94	19,05	46,03	17,46	7,94	-	-	-	-	-
	T	-	-	7,94	7,94	68,25	3,17	1,59	-	-	-	-	11,11
	R	-	-	4,76	-	34,92	-	38,1	-	1,59	-	-	20,63
As. 5	U	1,56	4,69	6,25	21,87	37,5	18,75	9,38	-	-	-	-	-
	T	-	-	7,81	6,25	62,5	3,12	6,25	1,56	-	-	-	12,5
	R	-	-	6,25	-	32,81	-	39,06	-	4,69	-	-	17,19

Asociation: As. 1 - *Asplenietum rutae-murariae-trichomanis*, As. 2 - *Asplenio quadrivalenti-Poëtum nemoralis*, As. 3 - *Asplenietum septentrionali-adianti-nigri*, As. 4 - *Asplenio trichomani-Poëtum nemoralis*, As. 5 - *Ctenidio-Polypodietum*.

Comparative analysis of rocky phytocoenoses behavior from Codru-Moma Mountains is presented in the following ecological spectrum.

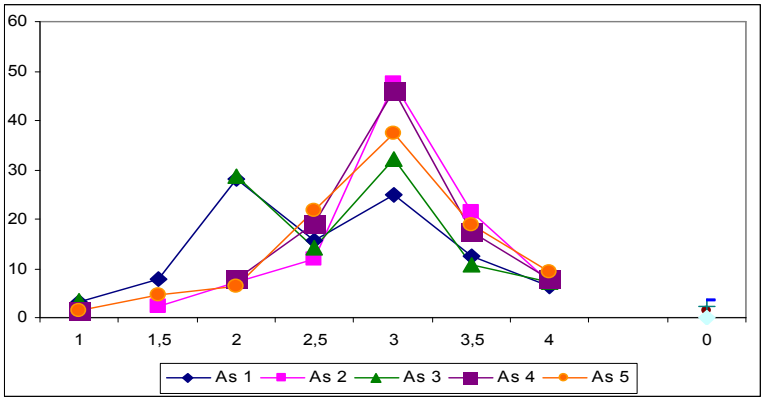

Fig. 5 Ecological comparative spectrum, for humidity

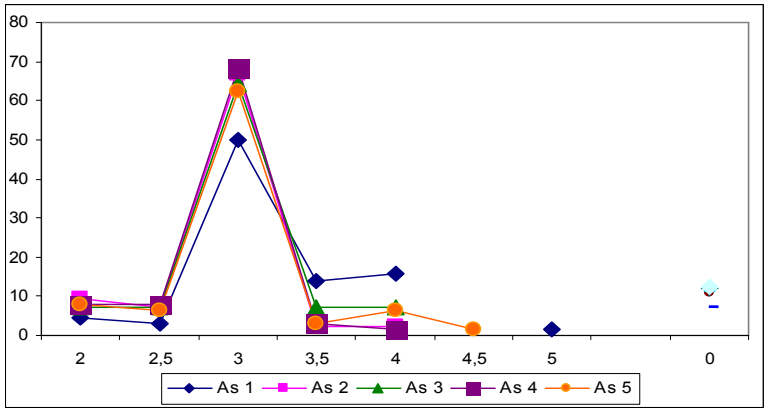

Fig. 6 Ecological comparative spectrum, for temperature

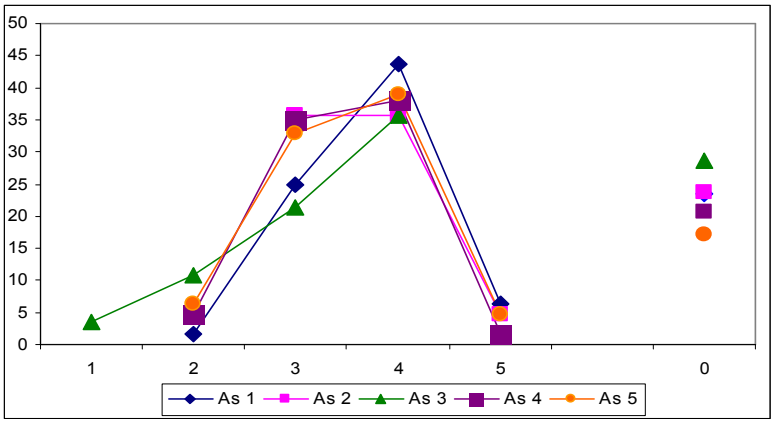

Fig. 7 Ecological comparative spectrum, for chemical reaction of soil

CONCLUSIONS

Considering humidity requirements (figure 5), it is observed that for *Asplenio quadrivalenti-Poëtum nemoralis, Asplenio trichomani-Poëtum nemoralis* and *Ctenidio-Polypodietum* associations the dominant species are mesophytes ($U_{3-3.5}$=56.25-69.05%), being the major components of rocky vegetations. The main species for *Asplenietum rutae-murariae-trichomanis* association are the xero-mesophytes ($U_{2-2.5}$=43.75%), and for *Asplenietum septentrionali-adianti-nigri* association the xero-mesophytes ($U_{2-2.5}$=42.86%) and mesophytes species ($U_{3-3.5}$=42.86%) dominate in equal share.

Considering temperature the micro-mesothermophylous species dominate for all the 5 associations studied (figure 6). Thus, on associations, values for the temperature index appears as follows: *Asplenietum rutae-murariae-trichomanis* ($T_{3-3.5}$=64.06), *Asplenio quadrivalenti-Poëtum nemoralis* ($T_{3-3.5}$=69.05), *Asplenietum septentrionali-adianti-nigri* ($T_{3-3.5}$=71.43), *Asplenio trichomani-Poëtum nemoralis* ($T_{3-3.5}$=71.43%), *Ctenidio-Polypodietum* ($T_{3-3.5}$=65.62%).

Analysis of species considering the chemical reaction of the soil, highlights the weak acid neutrophylous character for the most part of rocky phytocoenoses identified in the Codru-Moma Mountains (figure 7). The share of weak acid neutrophylous species in the 5 associations studied appears as follows: *Asplenietum rutae-murariae-trichomanis* association (R_4=43,75%), *Asplenio quadrivalenti-Poëtum nemoralis* association (R_4=35,71%), *Asplenietum septentrionali-adianti-nigri* association (R_4=35,71%), *Asplenio trichomani-Poëtum nemoralis* association (R_4=38,1%), *Ctenidio-Polypodietum* association (R_4=39,06%). The large share of basiphile species is explained by the existence of a limestone

substrate on extensive areas in Codru-Moma Mountains. Also the presence of the acidophile species is related to the acid substrate, met on high peaks.

REFERENCES

1. Alexiu V., 1998, Vegetaţia masivului Iezer-Păpuşa. Studiu fitocenologic, Edit. Cultura, Piteşti, 362p.
2. Borhidi A., 2003, Magyarország növénytársulásai, Akadémiai Kiadó, Budapest.
3. Burescu P., Păşcuţ C., 2010, Inputs to knowledge of rocks vegetation within Codru-Moma Mountains (NW Romania), „International Conference of Sciences" Analele Universităţii din Oradea, ISSN 1224-5119, Tom. XVII/1, pp.62-69.
4. Ciocârlan V., 2009, Flora ilustrată a României. *Pteridophyta* et *Spermatophyta*. Editura Ceres, Bucureşti.
5. Chifu T., Mânzu C., Zamfirescu O., 2006, Flora şi vegetaţia Moldovei (România) vol I-II, Edit. Univ. Al. I. Cuza Iaşi.
6. Chifu T., Irimia I., Zamfirescu O., 2014, Diversitatea fitosociologică a vegetaţiei României. I Vegetaţia erbacee naturală. Editura Institutul European, Iaşi, 603p.
7. Cristea V., Gafta D., Pedrotti F., 2004, Fitosociologie. Editura Presa Universitară Clujeană. Cluj-Napoca.
8. Drăgulescu C., 1995, Flora şi vegetaţia din bazinului văii Sadului. Editura Constant, Sibiu, 355p.
9. Diaconescu F., 1973, Aspecte din vegetaţia masivului Leaota, I. Anal. Şt. Univ. "Al. I. Cuza" Iaşi, Seria nouă, Secţ. II-a. Biol. 19, fasc. 2, pp.465-474.
10. Groza G., 2008, Flora şi vegetaţia Munţilor Pădurea Craiului. Editura Risoprint, Cluj-Napoca, 300p.
11. Karácsonyi C., 2011, Flora şi vegetaţia Dealurilor Tăşadului şi a colinelor marginale. Rezumatul tezei de doctorat, Arad.
12. Kolbek J., Valachovič M., Mîšikova K., 2015, Wall vegetation in old royal mining towns in Central Slovakia. Hacquetia 14/2, pp.249-263.
13. Mihăilescu S., 2001, Flora şi vegetaţia Masivului Piatra Craiului. Edit. Vergiliu Bucureşti, 400p.
14. Niculescu M., 2006, Flora şi vegetaţia bazinului superior al Râului Luncavăţ. Rezumatul tezei de doctorat, Cluj-Napoca, 358p.
15. Oprea A., Sîrbu C., 2009, Munţii Stânişoarei (Carpaţii Orientali). Studiu fitosociologic, Editura Universităţii „Alexandru Ioan Cuza'', Iaşi, 214p.
16. Pascal P., Mititelu D., 1971, Contribuţie la studiul vegetaţiei din bazinul Bistriţei Aurii (Jud. Suceava), Comunic Şti. Inst. Pedagog., Iaşi, pp.331-363.
17. Paucă A., 1941, Studiu fitosociologic în Munţii Codru şi Muma. Teză de doctorat M.O., Imprimeria Naţională, Bucureşti, 119p.
18. Păşcuţ C., 2010, The study of vegetal communities in Codru-Moma Mountains Analele Universităţii din Oradea, Fascicula: Protecţia Mediului, Vol. XV, Anul 15, Editura Universităţii din Oradea, Oradea, pp.513-518.
19. Păşcuţ C., 2013, Paucă (1941)-Păşcuţ (2012) - A comparative study on the vegetation in Codru-Moma Mountains. Analele Universităţii din Oradea, Fascicula: Protecţia Mediului, I.S.S.N. 1224-6255, vol. XX, pp.147-168.
20. Peia P., 1978, Aspecte de vegetaţie din Cheile Minişului. Contrib. Bot. Cluj-Napoca, pp.235-250.
21. Pignatti E., Pignatti S., 2014, Plant life of the Dolomites: Vegetation structure and ecology. Spinger Publishing House, Rome, 478p.

22. Pop I., Cristea V., Hodişan I., 2002, Vegetaţia judeţului Cluj. Studiu fitocenologic, ecologic, bioeconomic şi ecoprotectiv. Contrib. Bot. (1999-2000), Cluj-Napoca, 35, 2, pp.5-254.
23. Pott R., 1995, Die Pflanzengesellschaften Deutschlands, 2 Aufl., Ulmer Verlug, Stuttgart.
24. Raţiu O., Gergely I., 1976, Structura ecologică şi sintaxonomică a vegetaţiei Văii Sebişelului (Bazinul Văii Drăganului). Contrib. Bot., Cluj-Napoca, pp.73-102.
25. Raţiu O., Gergely I., Şuteu Ş., 1984, Flora şi unităţile fitosintaxonomice de pe Valea Iadului (jud. Bihor). Importanţa economică şi ştiinţifică. Caracterizarea lor ecologică III. Contrib. Bot., Cluj-Napoca, pp.85-135.
26. Răduţoiu D., 2006, Flora şi vegetaţia bazinului Cernei de Olteţ. Editura Sintech, Craiova, 407p.
27. Sârbu I., Ştefan N., Coroi M., Tănase C., Ciurăscu Ş., 1997, Rezervaţia naturală Cheile Năruiei - Lacul Negru (jud. Vrancea). Bul. Grăd. Bot., Iaşi, 6(1), pp.235-250.
28. Świerkosz K., 2004, Notes on the syntaxonomy of the *Asplenietea trichomanes* class in Poland. Polish Botanical Journal 49(2), pp.203-213.
29. Ştefan N., Sârbu I., Coroi M., Oprea A., Tănase C., Ciurăscu Ş., 1997, Rezervaţia naturală Cheile Tişiţei (jud. Vrancea). Bul. Grăd. Bot., Iaşi, 6(1), pp.251-274.
30. Sanda V., Popescu A., Doltu I., Doniţă N., 1983, Caracterizarea ecologică şi fitocenologică a speciilor din flora României. Stud. şi Com.. Muz. Brukenthal. Sibiu. supliment. 25, pp.1-126.
31. Sârbu I., Ştefan N., Oprea A., 2013, Plante vasculare din România. Determinator ilustrat de teren. Editura Victor B Victor. Bucureşti.
32. Schneider-Binder E., 1968, Consideraţii asupra fitocenozelor de *Asplenium septentrionale* (L.) Hoffm. din Carpaţii României. Contrib. Bot., Cluj-Napoca, pp.231-241.
33. Schneider-Binder E., 1969, Contribuţii la studiul clasei *Asplenietea rupestris* H. Meier et Br.-Bl. 1934. Contrib. Bot., Cluj-Napoca, pp.145-155.
34. Schneider-Binder E., 1972, Contribuţii la studiul asociaţiilor din alianţa *Asplenion septentrionalis* Gams 1927 în Carpaţii României. Muz. Brukenthal, Studii şi Comunic. Şti. Nat., Sibiu, 17, pp.167-181.
35. Stancu I., D., 2005, Flora şi vegetaţia Munţilor Râiosu şi Buda, Masivul Făgăraş. Editura Universităţii din Piteşti.