

THE VEGETATION OF NORTHERN PART OF BIHORULUI MOUNTAINS, ROMANIAN CARPATHIANS

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Abstract

The aim of research conducted over the period 2010-2013 in the northern part of Bihor Mountains, within the Apuseni Mountains (Romanian Carpathians), was studying the herbaceous and woody vegetation and from that territory. Those over 650 relevés conducted on approximately 360 square kilometers, comprised ranging from beech to spruce, coniferous shrubs, meadows oligotrophic, mesophilic xerophile used as pasture or meadow, limestone and siliceous rocks and scree, aquatic and swamp vegetation, the tall weeds. Have been inventoried and briefly described 75 plant associations belonging to 39 alliances, 32 orders and 17 classes of vegetation. The studied territory has already been included in the Apuseni Natural Park and the Natura 2000 site - ROSCI002 Apuseni.

Key words: Apuseni Mountains, Bihor Mountains, conspectus, plant associations, mountainous and subalpine vegetation.

INTRODUCTION

The Bihor Mountains form the central axis of the Apuseni Mountains, within the Romanian Carpathians (Pop, 2006). These mountains represents, from geological terms, a complex structure, in which the calcareous substrates stand out in the central plateau surrounded by massive crystalline rocks, acidic, with high elevations over 1600 m altitude in the northern part (Bleahu, 1981). The average annual temperature of 2°C and average annual rainfall of over 1400 mm, specific to higher mountains, due to positioning the Bihor Mountains, here is discharged most of the moisture brought by the winds from the west, more humid. The hypsometric analysis of the territory, GIS performed, reveals that the widest land surfaces (35.6%) are between 1200-1400 meters altitude between 1000-1200 m (33.4%), the surfaces between 800-1000 meters recorded 17.6% and those situated between 1400 to 1600 meters represents 6.5%. The surfaces situated at more than 1600 meters altitude represents only 0.7% of the territory, and those located between 400-800 m occupy 6.2%. Slopes exposure of the studied area is as follows: sunny slopes: 26%, partly sunny 47%, shadowed 27%. Depending on the inclination of the slopes, the widest area are in the class 10-20° (40.2%), while the plateaus with slopes between 0-5° represents only 5.31%; strongly inclined slopes, with inclinations of 35-45° represents 4.89%, the vertical walls from the gorges, vertical caves

and rocky massives which presents cracks and shelves on which are fixed the saxicolous vegetation, occupies 0.51%. Most common soils are Cambisols (44.9%), with a pH ranging from 5.1 to 7.7, followed by Cernisols formed on limestone, on the rough relief forms (18.1%). The Hidric soils of brooks and rivers of valleys with specific vegetation occupies 2.9%, while the Histic soils, which conditioning the local flora and vegetation typical, relict, of peat bog, occupies 0.6% of the territory. The climatic conditions favors the forest vegetation extended over large areas on the acidic rocks, while on the karst plates from Padiș, Scărișoara, Vărsașoia, Călineasa, Mărșoia, the meadows are prevalent. Phenomenon of thermal inversion of limestone plateaus, especially in the Padiș area, favors the vegetation inversions, in some places the beech forests and mixed beech-spruce forests being placed over the spruce forests. The specific relief and micro-climate conditions allow the presence, especially in the keys, canyons, limestone walls and at the entrance of caves, a relict, endemic or rare plant species.

From floristic and phyto-sociological point of view, the territory of the northern part of Bihor Mountains is scarcely known, the publications from this area are relatively few and fragmentary (Boșcaiu et Marossy 1980-1981; Coldea, 2002; Coldea et al., 2008; Csűrös et al., 1962; Kovács, 1967; E. Pop, 1939; E. Pop, 1940; I. Pop et Hodișan, 1962; I. Pop et Hodișan, 1967; I. Pop et al., 1965; I. Pop et al., 1987; Simon, 1966).

MATERIAL AND METHODS

Territory with an area of 360 sq.km was studied over the period 2010-2013. During the field observations and research, we have used methods of phytosociological research of the Central-European School, based on the principles and methodologies developed by Braun-Blanquet (1928) and adapted by Borza (1934), Borza and Boșcaiu (1965) to the particularities of the vegetation layer in our country. More than 650 phytocoenological surveys done during the field trips, comprised sample surfaces that were representative, homogenous from a floristic and physiognomic point of view, which were chosen in the fragments characteristic to the researched phytocoenoses.

The phytocoenoses' associations identified in the researched area, phytocoenoses were grouped into sub-alliances, alliances, orders and classes of vegetation, according to the European central coeno-taxonomic model used by Oberdorfer (1992), Mucina (1997), Rodwell et al. (2002). They have also been used synthesis of the vegetation work of Romania: Coldea (1991), Coldea et al. (1997), Sanda (2002), Sanda et al., (2008). The name of associations was made according to established the International Code of Phytosociological Nomenclature, 3rd edition, Weber et al. (2000).

The classification of the associations habitat based, was made according Doniță et al. (2005), Sârbu et al. (2007), Gafta et al. (2008) and the Interpretation Manual of European Union Habitats - EU28 (2013).

The botanical nomenclature used is the one developed for Romanian flora by Ciocârlan (2009).

RESULTS AND DISCUSSION

On the basis of relevées recorded, we found that the researched territory, the northern part of Bihor Mountains, has a high diversity of vegetation, according to soil and climatic conditions. Plant communities identified were classified into 76 associations, 40 alliances, 33 orders and 18 classes presented in the following coeno-taxonomic conspectus. Of the 76 associations presented here, a total of 38 have not been previously published from the northern part of Bihor Mountains.

I. POTAMOGETONETEA PECTINATI Tüxen et Preising 1942

CALLITRICHIO-BATRACHIETALIA Passarge 1964

Ranunculion aquatilis Passarge 1964

1. *Callitrichetum palustris* (Dihoru 1975 *n.n.*) Burescu 1999

II. ISOËTO-NANOJUNCETEA Br.-Bl. et Tüxen ex Westhoff et al. 1946

NANOCYPERETALIA Klika 1935

Nanocyperion Koch ex Libbert 1932

2. *Juncetum bufonii* Felföldi 1942

III. PHRAGMITETEA AUSTRALIS Tüxen et Preising 1942

NASTURTIO-GLYCERIETALIA Pignatti 1953

Sparganio-Glicerion fluitantis Br.-Bl. et Sissingh 1942

3. *Glicerietum plicatae* (Kulczynski 1928) Oberdorfer 1952

OENANTHETALIA AQUATICAE Hejný in Kopecký 1961 ex Hehný 1965

Oenanthetion aquaticae Hejný ex Neuhausl 1959

4. *Eleocharitetum palustris* Schennikov 1919

MAGNOCARICETALIA Pignatti 1953

Magnocaricion elatae Koch 1926

Caricenion rostratae (Balátová-Tuláčková 1963)

Oberdorfer et al. 1967

5. *Caricetum rostratae* Rübel 1912

Caricenion gracilis (Neuhausl 1959) Oberdorfer et al. 1967

6. *Caricetum vesicariae* Chouard 1924

IV. MONTIO-CARDAMINETEA Br.-Bl. et Tüxen 1943

- MONTIO-CARDAMINETALIA** Pawłowski 1928
Cardaminion amarae Mass 1959
 7. *Cardamino-Chrysosplenietum alternifolii* Maas 1959
Cardamino-Montion Br.-Bl. 1926
 8. *Philonotido-Calthetum laetae* (Krajina 1939) Coldea 1991
 9. *Carici remotae-Calthetum laetae* Coldea (1972) 1978
- V. SCHEUCHZERIO-CARICETEA NIGRAE** Tüxen 1937
SCHEUCHZERIO-CARICETALIA NIGRAE Nordhagen 1937
Rhynchosporion albae Koch 1926
 10. *Caricetum limosae* Br.-Bl. 1921
 11. *Sphagno cuspidati-Rhynchosporietum albae* Osvald 1923 em. Koch 1926
- CARICETALIA NIGRAE** Koch 1926
Caricion nigrae Koch 1926 em. Klika 1934
 12. *Junco-Caricetum nigrae* Tüxen (1937) 1952
 13. *Sphagno-Caricetum rostratae* Steffen 1931
 14. *Carici echinatae-Sphagnetum* (Balázs 1942) Soó 1955
- CARICETALIA DAVALLIANAE** Br.-Bl. 1949
Caricion davallianae Klika 1934
 15. *Carici flavae-Eriophoretum latifolii* Soó 1944
 16. *Carici flavae-Blysmetum compressi* Coldea 1997
- VI. OXYCOCCO-SPHAGNETEA** Br.-Bl. et Tüxen ex Westoff et al. 1946
SPHAGNETALIA MAGELLANICI (Pawłowski 1928) Moore 1968
Sphagnion magellanici Kästner et Flösner 1933
 17. *Sphagnetum magellanici* (Malcuit 1929) Kästner et Flösner 1933
 18. *Eriophoro vaginati-Sphagnetum recurvi* Hueck 1925
- VII. ASPLENIETEA TRICHOMANIS** (Br.-Bl. in Meier et Br.-Bl. 1934) Oberdorfer 1977
TORTULO-CYMBALARIETALIA Segal 1969
Cymbalario-Asplenion Segal 1969 em. Mucina 1993
 19. *Asplenietum rutae-murariae – trichomanis* Tüxen 1937
Cystopteridion Richard 1972
 20. *Cystopteridetum fragilis* Oberdorfer 1938
 21. *Asplenio quadrivalenti-Poëtum nemoralis* Soó ex Gergely et al. 1966
- ANDROSACETALIA VANDELII** Br.-Bl. in Meier et Br.-Bl. 1934
Asplenion septentrionalis Oberdorfer 1938

22. *Asplenio-Caricetum brachystachyos* Richard 1972
 23. *Valeriano montanae-Cortusetum matthioli* Boşcaiu et Täuber 1978
 24. *Asplenio trichomani-Poëtum nemoralis* Boşcaiu 1971
Hypno-Polypodium Mucina 1993
 25. *Ctenidio-Polypodietum* Jurko et Peciar 1963
 26. *Hypno-Polypodietum vulgaris* Jurko et Peciar 1963
- VIII. SESLERIETEA ALBICANTIS** Br.-Bl. 1948 em. Oberdorfer 1978
SESLERIETALIA ALBICANTIS Br.-Bl. in Br.-Bl. et Jenny 1926
Seslerion rigidae Zólyomi 1939
 27. *Asperulo capitatae-Seslerietum rigidae* (Zólyomi 1939) Coldea 1991
 28. *Campanulo kladniana-Calamagrostetum variae* Coldea 1997
- IX. THLASPIETEA ROTUNDIFOLII** Br.-Bl. 1926
THLASPIETALIA ROTUNDIFOLII Br.-Bl. 1926
Achnatherion calamagrostis Br.-Bl. 1918
 29. *Thymo comosi-Galietum albi* Sanda et Popescu 1999
 30. *Parietarietum officinalis* Csűrös 1958
- X. NARDO-CALLUNETEA** Preising 1949
NARDETALIA Oberdorfer 1949
Potentillo-Nardion Simon 1959
 31. *Scorzonero roseae-Festucetum nigricantis* (Puşcaru et al. 1956) Coldea 1987
 32. *Violo declinatae-Nardetum strictae* Simon 1966
 33. *Carici-Nardetum strictae* (Resmeriţă 1984) Resmeriţă et Pop 1986
Genistion pillosae Duvigneaud 1942
 34. *Vaccinio-Callunetum vulgaris* Bükér 1942
- XI. MOLINIO-ARRHENATHERETEA** Tüxen 1937
MOLINIETALIA CAERULEAE Koch 1926
Molinion caeruleae Koch 1926
 35. *Junco-Molinietum* Preising 1951
Filipendulion Lohmeyer in Oberdorfer et al. 1967
 36. *Filipendulo-Geranium palustre* Koch 1926
 37. *Chaerophyllo hirsuti-Filipenduletum* Niemann et al. 1973
Calthion palustre Tüxen 1937
 38. *Ranunculo repentis-Calthetum palustre* Chifu et al. 2006
 39. *Angelico-Cirsietum oleracei* Tüxen 1937

40. *Scirpetum sylvatici* Ralski 1931, Maloch 1935 em. Schwick 1944
- ARRHENATHERETALIA** Tüxen 1931
- Cynosurion** Tüxen 1937
41. *Festuco rubrae-Agrostetum capillaris* Horvat 1951
42. *Anthyllido vulnerariae-Festucetum rubrae* (Máthé et Kovács 1960) Soó 1971
43. *Anthoxantho-Agrostietum capillaries* Sillinger 1933
- POTENTILLO-POLYGONETALIA** Tüxen 1937
- Juncenion effuse** Westhoff et van Leeuwen ex Hejny et al. 1979
44. *Juncetum effusi* Soó (1931) 1949
- DESCHAMPSIETALIA CAESPITOSAE** Horvatić 1956
- Deschampsion caespitosae** Horvatić 1930
45. *Deschampsietum caespitosae* Hayek ex Horvatić 1930
46. *Caricetum brizoidis* Rațiu 1966
- XII. FESTUCO-BROMETEA** Br.-Bl. et Tüxen 1937 in Br.-Bl.
- STIPIO PULCHERRIMAE-FESTUCETALIA PALLENTIS** I.Pop 1968
- Seslerio-Festucion pallentis** Klika 1931
47. *Asplenio rutaemurariae – Melicetum ciliatae* Soó 1962
- FESTUCETALIA VALESIACAE** Br.-Bl. et Tüxen 1937 ex Br.-Bl. 1949
- Festucion valesiacae** Klika 1931
48. *Sedo sexangulari-Syntrichietum calcicolae* Mihai et al. 1973
49. *Koelerietum macranthae* (Răvăruț et al. 1956) Popescu et Sanda 1988
- XIII. GALIO-URTICETEA** Passarge 1967 em. Kopecký 1969
- LAMIO ALBI-CHENOPODIETALIA BONI-HENRICI** Kopecký 1969
- Rumicion alpini** (Rübel 1933) Klika 1944
50. *Rumici obtusifoliae-Urticetum dioicae* Kornás 1968
51. *Urtico dioicae-Rumicetum alpini* (Șerbănescu 1939, Todor et Culică 1967) corr. Oltean et Dihoru 1986
52. *Veratretum albi* (Pușcaru et al. 1956) Buia et al. 1962
- CONVOLVULETALIA SEPIUM** Tüxen em. Mucina 1993
- Petasition officinalis** Sillinger 1933 em. Kopecký 1969
53. *Telekio-Petasitetum hybridi* (Morariu 1967) Resmeriță et Rațiu 1974
- XIV. BETULO-ADENOSTYLETEA** Br.-Bl. et Tüxen 1943

- ADENOSTYLETALIA ALLIARIAE** Br.-Bl. 1931
Adenostylon alliariae Br.-Bl. 1925
54. *Adenostylo-Doronicetum austriaci* Horvat 1956
- XV. EPILOBIETEA ANGUSTIFOLII** Tüxen et Preising in Tüxen 1950
ATROPETALIA Vlieger 1937
Carici piluliferae-Epilobion angustifolii Tüxen 1950
55. *Calamagrostio arundinaceae-Digitalietum grandiflorae* Oberdorfer 1973
56. *Senecioni sylvatica-Epilobietum angustifolii* Tüxen 1937
- SAMBUCETALIA RACEMOSAE** Oberdorfer 1957
Sambuco racemosae-Salicion capreae Tüxen et Neumann in Tüxen 1950
57. *Fragario-Rubetum idaei* Gams 1927
- XVI. TRIFOLIO-GERANIETEA SANGUINEI** Müller 1961
TRIFOLIO-ORIGANETALIA (Müller 1961) Zimmermann et al. 1989
Trifolion medii Müller 1961
58. *Clinopodio-Pteridietum aquilini* Dihoru 1975
- XVII. QUERCO-FAGETEA** Br.-Bl. Et Vlieger in Vlieger 1937 em. Borhidi 1996
FAGETALIA SYLVATICAE Pawłowski in Pawłowski et al. 1928
Symphyto cordati-Fagion Vida 1959
Symphyto-Fagenion Boşcaiu et al. 1982
59. *Symphyto cordati-Fagetum* Vida 1963
60. *Pulmonario rubrae-Fagetum* (Soó 1964) Täuber 1987
61. *Taxo-Fagetum* Etter 1947
62. *Festuco drymejae-Fagetum* Morariu et al. 1968
63. *Leucanthemo waldsteinii-Fagetum* (Soó 1964) Täuber 1987
Moehringio muscosae-Acerenion Boşcaiu et al. 1982
64. *Phyllitidi-Fagetum* Vida (1959) 1963
Epipactido-Fagenion Boşcaiu et al. 1982
65. *Epipacteto-Fagetum* Resmeriță 1972
66. *Seslerio rigidae-Fagetum* Soó et Vida 1963
- XVIII. VACCINIO-PICEETEA** Br.-Bl. in Br.-Bl. et al. 1939
PICEETALIA EXCELSAE Pawłowski in Pawłowski et al. 1928
Piceion excelsae Pawłowski in Pawłowski et al. 1928
Soldanello majori-Picenion Coldea 1991
67. *Soldanello majori-Piceetum* Coldea et Wagner 1998

68. *Hieracio transsilvanico-Piceetum* Pawłowski et Br.-Bl. 1939
69. *Doronico columnae-Piceetum* Coldea 2002
- ATHYRIO-PICEETALIA** Hadač 1962
- Chrysanthemo rotundifolia-Piceion** (Krajina 1933) Březina et Hadač 1962
70. *Leucanthemo waldsteinii-Piceetum* Krajina 1933
- Abieti-Piceion** (Br.-Bl. in Br.-Bl. et al. 1939) Soó 1964
71. *Sphagno girgensohnii-Piceetum* Kuach 1954
- JUNIPERO-PINETALIA MUGI** Boşcaiu 1971
- Pinion mugi** Pawłowski 1928
72. *Pino mugo-Sphagnetum* Kästner et Flössner 1933
73. *Calamagrostio villosae-Piceetum* (Coldea et Pânzariu 1986) Sanda et al. 2001
- MYRTILLO-PICEETALIA** Hadač 1962
- Myrtillo-Piceion excelsae** Březina et Hadač 1962
74. *Myrtillo-Piceetum excelsae* Březina et Hadač 1962
- VACCINIO-JUNIPERETALIA** Passarge et Hoffmann 1968
- Vaccinio-Juniperion communis** Passarge et Hoffmann 1968
75. *Piceeto-Juniperetum sibiricae* Br.-Bl. 1930
76. *Vaccinio-Juniperetum communis* Kovács 1979

Of the total of 360 sq.km studied, 305 sq.km are covered with natural vegetation (84.6%), the rest having other uses (roads, hearths of human settlements, agricultural land, etc.). From this surface of natural vegetation, forests cover 74%, 21% are grassland, rocky 1.5% and 3.5% are water, wetlands and peatlands.

The general characteristic of the natural landscape of researched territory is given by the presence of large spruce forests, mixed forests and pure beech forests, arranged altitudinal, interrupted by large surfaces covered with grasslands and rocky pigmented remarkable landscape and botanical and , in depressionary places, where substrate conditions are met, are formed peat bogs with relict species.

The edified forests of pure beech, at lower altitudes in the west, or mixed with spruce or fir, at higher altitudes, occupies middle mountain sublevel (700-1200 m). These forests are present in the peripheral areas of the territory in the south-east, were classified to the sub-alliances **Symphyto-Fagenion**, **Calamagrostio-Fagenion**, **Moehringio muscosae-Acerenion**, **Epipactido-Fagenion**. Insular, as effect of thermal inversions, mixed beech forests goes up at altitudes above 1400 m, into closed basin Padiş - Cetățile Ponorului, the peaks Piatra Boghii, Balileasa, Biserica

Motului etc. Also as a result of thermal inversions, under a cool and humid climate, spruce forests down to 600-800 m, at Albac Valley in the southeastern part of the Aries Valley, or the deep sinkholes of Cetățile Ponorului at 700-800 m altitude.

The forests from upper mountain sublevel (1200-1600 m) are characterized by the presence of *Picea abies* edified forests, at the lower limit of this level is present also fir (*Abies alba*). The associations were identified in the territory where assigned to the orders **PICEETALIA EXCELSAE**, **ATHYRIO-PICEETALIA**, **MYRTILLO-PICEETALIA**. The coniferous forests are spread massive compact in the basin of Someșului Cald river, also in the upper basin Arieș river and in large areas of karst plateaus Padiș-Cetățile Ponorului and Ocoale-Scărișoara. The transition from the nemoral floor, of beech, to the boreal floor, of the spruce is often gradually by beech-fir forests, while the sub-alpine transition is smooth, by limit plant formations with juniper and other species undergrowth.

Subalpine meadows appear from great heights, over 1600 m, at the northern limit of the territory under Coasta Brăieșei, which borders Vlădeasa Massif. Vegetation consists mainly of associations mesophilic, acidophilic and acidophilic strongly with *Nardus stricta* and *Festuca rubra*, while the territory on the high peaks is colonized by subalpine and mountain shrubs with *Juniperus communis* and *Vaccinium myrtillus*.

The associations developed on deforested areas are falling within **ATROPETALIA** order, with the edifying species *Calamagrostis arundinacea* and *Epilobium angustifolium*, respectively, in order **SAMBUCETALIA RACEMOSAE** (associations with *Rubus idaeus*).

Grasslands occupy the upper basin of the Arieș river the coasts and ridges not very high, rising to 1200-1350 m altitude, being used as hay or pasture. The karst plateaus Padiș, Ocoale, Bătrâna, Mărșoia, Ursoaia due to the limestone substrate, have the base generally lack of water and forest vegetation, allowing the installation of meadows, used mainly for grazing. Hayfields from Casa de Piatră and from Valley Gârda, on the wide platform of karst Ocoale were included at associations belonging to the order **ARRHENATHERETALIA**. Mountain meadows from karst plateaus with pasture role falling within the same order and to the order **NARDETALIA** develops especially in depressionary areas, marginal ridges being almost always covered by forests, such as in the karst plateau Padiș - Cetățile Ponorului. The siliceous substrate, acidic, well represented the North Someșului Cald Valley to Coasta Brăieșei and Piatra Arsă, meadows with *Nardus stricta* belonging to **NARDETALIA** order, occupy large areas used for grazing animals.

Limestone rocky regions, very well represented in the territory and representing touristic, landscape and botanical special attractions and screes at basis of rock walls have specific vegetation with numerous protected species, rare, vulnerable. The associations identified where assigned to the classes **ASPLENIETEA TRICHOMANIS**, **SESLERIETEA ALBICANTIS**, **FESTUCO-BROMETEA** and, respectively, **THLASPIETEA ROTUNDIFOLII**.

In wet places located along rivers grows specific vegetation, the associations identified where assigned, as appropriate, to the orders **MONTIO-CARDAMINETALIA**, **MOLINIETALIA CAERULEAE**, **CONVOLVULETALIA SEPIUM**. The phytocoenoses from the edge of small water surfaces of the plateau Padiş were included to associations belonging to classes **OENANTHETALIA AQUATICAE**, **MAGNOCARICETALIA**, **CARICETALIA DAVALLIANAE**.

In the spruce forests area have been developed peatbogs and swamps, locally called "molhaş". These have been formed on siliceous substrates waterproofed, sometimes near water courses (Molhaşurile de la Izbuc, peat bogs from Călineasa Plateau, peat bogs from Padiş plate, on the valleys Trânghieşti, Renghii, Arsurii, Gârjoaba), or heights horizontal (Vânăta Măgura, Piatra Arsă-Vărăşoaia). Other peatland have been formed in the karst areas, the sinkholes where the bottom is waterproofed with clay (Şesul Padiş, Groapa de la Barsa). Due to the cold and wet climate in these "molhaş" found refuge some relict species and plant associations. The associations described in peatbogs belonging to classes **SCHEUCHZERIO - CARICETEA NIGRAE** and **OXICOCCO-SPHAGNETEA**.

CONCLUSIONS

The researched vegetal cover in the northern part of the Bihor Mountains belonging to 76 associations identified, of which 18 represent deciduous and coniferous forests and hedges, 19 represent oligotrophic grasslands, hydrophilic, meso-hygrophilic, mesophilic, xero-mesophilic, xerophilic, 12 represent pioneer plant groups on rocks and scree, 9 are from the high weeds and 18 represent aquatic and swamp vegetation, eutrophic, meso-oligotrophic, oligotrophic and eu-mesotrophic.

Many plant associations define habitats of Community importance, shelter rare, endemic, vulnerable, endangered species. Management of these areas included in Nature 2000 habitat ROSCI0002 Apuseni and also to the Natural Park Apuseni must consider first the principles of conservation of species and habitats.

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