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SHRUBS-DOMINATED VEGETATION IN NEAGRA BROŞTENILOR RIVER BASIN (ROMANIAN EASTERN CARPATHIANS)

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Abstract: The article presents a numerical analysis of shrubs-dominated vegetation in Neagra Broştenilor river basin (Romanian Eastern Carpathians). The study focuses on the floristic variability and syntaxonomic diversity of these vegetation types, on diagnostic species, and ecological preferences. Data classification, carried out using a hierarchical agglomerative clustering procedure, revealed seven well-defined plant communities, related to associations described in the literature based on their diagnostic species: *Digitali ambigue - Calamagrostietum arundinaceae* Sillinger 1933 subass. *spiraeetosum chamaedryfoliae* (Resm. et Csűrös 1966) Coldea 1991, *Rubetum idaei* Gams 1927, *Salici - Alnetum viridis* Colic et al. 1962, *Rhododendro myrtifolii - Pinetum mugo* Coldea 1991, *Rhododendro myrtifolii - Vaccinietum* Coldea et al. 1981, *Campanulo abietinae - Juniperetum nanae* Simon 1966 and *Empetro - Vaccinietum gaultherioidis* Br.-Bl. in Br.-Bl. et Jenny 1926 corr. Grabherr in Grabherr et Mucina 1993. All described syntaxa were characterized in terms of diagnostic, constant and dominant species, distribution, and aspects related to floristic and phytosociological composition.

Keywords: diversity, floristic composition, numerical classification, shrub vegetation, syntaxonomy.

Introduction

Classification and description of shrubs-dominated vegetation represent useful tools for their inventory and monitoring, as well for development of particularized management, conservation and restauration projects [BIURRUN & al. 2019; PEET & ROBERTS, 2013]. Also, vegetation is used to define habitat types, some of them considered priorities for conservation.

The Neagra Brostenilor river basin is located in the central area of the Bistrița Mountains (where crystalline geological formations predominate) and include a small area in the eastern slopes of the Călimani Mountains (of volcanic nature) and the Drăgoiasa – Glodu depression (with sedimentary geological formations). The river is 42 km long, and the hydrographic basin has an area of approximately 350 km^2 on the territory of Suceava County [Atlasul cadastrului apelor din R.S.R., 1972]. The maximum elevation is on the Căliman Izvor peak (2033 m), and the minimum at Broșteni (630 m), while the Drăgoiasa – Glodu depression is located at approximately 1000 m altitude. From a pedological perspective, this river basin overlaps the domain of mountain soils, with characteristic units and subunits [BARBU & al. 1984]. In addition, peaty soils are found in limited areas in some intra-montane depressions. The climate is specific to the mountain areas, characterized by average precipitation values of

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600-1100 (1200) mm/year (depending on altitude) and mean annual temperatures between 0 and 4 ºC.

The only protected area that partially overlaps the Neagra Broştenilor basin is the Călimani Mountains National Park. It is characterized by a remarkable diversity of both cormophyte species, cryptogam species and habitat types [SÂRBU, 2007], as 6230* Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas, 4070* Bushes with *Pinus mugo* and *Rhododendron hirsutum* (*Mugo-Rhododendretum hirsuti*) or 9420 Alpine *Larix decidua* and/or *Pinus cembra* forests, etc.

The first published vegetation data from the study area resulted from investigations carried out by CSŰRÖS (1951), in the Călimani Mountains. The author reported four plant associations from the area of the Izvorul Călimanului and Călimanul Cerbului peaks, and characterized the subalpine belt distinguishing several plant associations (e.g. *Pinetum mughi carpaticum*), without making detailed specifications on their floristic composition. A few years later, POP (1960) reported the peat bog from Drăgoiasa, noting that flora is poor, including species adapted to the specific conditions of the peatbogs and presented few syntaxa dominated by Cyperaceae species, without phytosociological tables.

A particularly important contribution to the study of the flora and vegetation of cormophytes and bryophytes in the Neagra Broştenilor river basin was made by LUNGU (1971), who studied the peat bog located on the right side of the Cristişor stream, as part of her doctoral thesis. From this territory, with an area of only 14 ha, the author presented a wide range of herbaceous phytocoenoses characteristic of peat bogs and marshy meadows. The woody vegetation was represented by alder communities that follow the water courses and spruce forests on the slopes. SEGHEDIN (1986), in his doctoral thesis, approached the study of the flora and vegetation of the Bistrița Mountains, and from the total of 22 associations the author presented several phytocoenoses from the association *Rubo - Chamenerietum* Hadač 1969.

Data on the vegetation of the studied area were also published in various synthesis works [MITITELU & al. 1987; MITITELU & al. 1989; POPOVICI & al. 1996], presenting numerous syntaxa from various localities, but without description or phytosociological tables. As can be seen, the studies are numerous and well documented. However, it can be noted that they do not cover the entire area and the entire phytosociological diversity of the study area. Thus, this paper was focused on the floristic variability and syntaxonomical diversity of shrubs-dominated plant communities in Negra Broştenilor basin, on their diagnostic species, and on their ecological preferences.

Material and methods

The current analysis was based on a dataset consisting on 40 relevés. The methodological approach used to conduct the relevés was developed by Zürich-Monpellier School of vegetation study [BRAUN-BLANQUET, 1964]. They were classified using a hierarchical agglomerative clustering procedure (ß-flexible algorithm with ß = -0.25, Bray-Curtis dissimilarity and square root-transformed data of the mid-percentage values corresponding to the Braun-Blanquet cover-abundance scale). The classification procedure was carried out using the Gingko software within the VEGANA package [BOUXIN, 2005]. The optimum number of clusters was identified using the corrected Rand index and the mean Silhouette index.

Diagnostic species were identified based on their fidelity - the phi index [TICHÝ & CHYTRÝ, 2006], while the Fisher's exact test allowed to retain only species statistically

significant associated to the clusters. Based on the diagnostic species, the clusters were assigned to the phytosociological associations described in literature [COLDEA, 1991; COLDEA, 2015; ŠIBÍK & al. 2010]. Nomenclature of plant species followed Euro+Med PlantBase (2006-) while classification to higher syntaxa mainly followed MUCINA & al. (2016).

Results and discussions

The cluster analysis (highlighted in the dendrogram) indicated seven interpretable clusters (Figure 1). Cluster one included perennial semi-natural vegetation on acidic soils while cluster two comprised red raspberry communities on nutrient-rich soils, all developed in forest margins and clearings or on disturbed forests soils. Cluster three included subalpine green alder scrubs on nutrient-rich soils, and cluster four consisted on subalpine silicicolous pine krummholz. Clusters five and six comprised subalpine, chionophilous, low juniper scrubs and acidophilous *Rhododendron myrtifolium* heaths, while cluster seven included subalpine dwarf *Vaccinium* sp. heaths in wind-exposed habitats, on silicicolous substratum. The floristic composition of all seven groups is well differentiated, and all are characterized by a significant number of diagnostic species (Table 1).

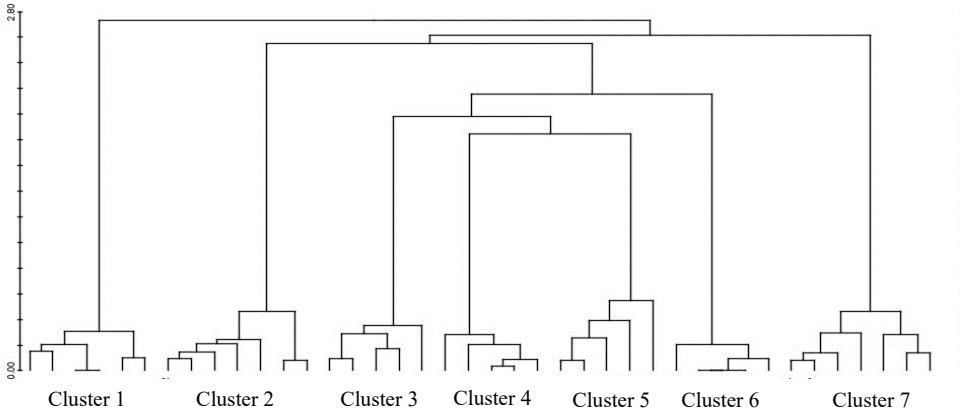

Figure 1. Dendrogram showing the results of the cluster analysis of the 40 relevés based on the Flexible β and Bray-Curtis distance.

Syntaxonomic scheme

EPILOBIETEA ANGUSTIFOLII R. Tx. et Preising ex von Rochow 1951
- GALEOPSIO-SENECIONETALIA SYLVATICI Passarge 1981
  - Epilobion angustifolii Oberd. 1957
    - Ass. *Digitali ambigue - Calamagrostietum arundinaceae* Sillinger 1933 *spiraeetosum chamaedryfoliae* (Resm. et Csűrös 1966) Coldea 1991
- SAMBUCETALIA RACEMOSAE Oberd. 1957
  - Sambuco-Salicion capreae Tx. et Neumann ex Oberd. 1957
    - Ass. *Rubetum idaei* Gams 1927

ROSO PENDULINAE-PINETEA MUGO Theurillat in Theurillat et al. 1995
- JUNIPERO-PINETALIA MUGO Boşcaiu 1971
  - Pinion mugo Pawlowski et al. 1928

Ass. *Rhododendro myrtifolii - Pinetum mugo* Coldea 1991

BETULO CARPATICAE-ALNETEA VIRIDIS Rejmánek ex Boeuf, Theurillat, Willner, Mucina et Simler in Boeuf et al. 2014

ALNETALIA VIRIDIS Rübel ex Karner etWillner in Willner et Grabherr 2007

Alnion viridis Schnyder 1930

Ass. *Salici - Alnetum viridis* Colic et al. 1962

LOISELEURIO- ACCINIETEA Eggler ex Schubert 1960

RHODODENDRO FERRUGINEI-VACCINIETALIA Br.-Bl. in Br.-Bl. et Jenny 1926

Loiseleurio procumbentis-Vaccinion Br.-Bl. in Br.-Bl. et Jenny 1926

Ass. Empetro - Vaccinietum gaultherioidis Br.-Bl. in Br.-Bl. et Jenny 1926 corr. Grabherr in Grabherr et Mucina 1993

Rhododendrion myrtifolii de Foucault ex Theurillat et Mucina 2016

Ass. *Rhododendro myrtifolii - Vaccinietum* Coldea et al. 1981

VACCINIO MICROPHYLLI-JUNIPERETALIA NANAE Rivas-Mart. et Costa 1998

Juniperion nanae Br.-Bl. in Br.-Bl. et al. 1939

Ass. *Campanulo abietinae - Juniperetum nanae* Simon 1966

Cluster 1. Ass. *Digitali ambigue - Calamagrostietum arundinaceae* Sillinger 1933 subass. *spiraeetosum chamaedryfoliae* (Resm. et Csűrös 1966) Coldea 1991

Diagnostic species: *Ajuga reptans*, *Angelica sylvestris*, *Betula pendula*, *Cirsium oleraceum*, *Dactylis glomerata* subsp. *glomerata*, *Digitalis grandiflora*, *Dryopteris filix-mas*, *Fagus sylvatica* juv., *Gentiana asclepiadea*, *Leucanthemum vulgare* subsp. *vulgare*, *Luzula luzuloides*, *Picea abies*, *Scrophularia nodosa*, *Hylotelephium maximum*, *Silene nutans* subsp. *dubia*, *Solidago virgaurea* subsp. *virgaurea*, *Spiraea chamaedryfolia*, *Stachys sylvatica*, *Trifolium repens* subsp. *repens*, *Veronica urticifolia*.

Constant species: *Campanula abietina*, *Gnaphalium sylvaticum*, *Hypericum maculatum*, *Lonicera xylosteum*, *Oxalis acetosella*, *Rubus idaeus*, *Salix caprea*, *Sambucus racemosa*, *Sorbus aucuparia* subsp. *aucuparia*.

Dominant species: *Calamagrostis arundinacea*, *Spiraea chamaedryfolia*.

This subassociation includes shrub communities sporadically spread in Neagra Broştenilor river basin, on former forest cuttings, on the administrative territory of Neagra Broşteni, and Dârmoxa localities. They are installed on deforested slopes, with inclinations varying between 25 - 40º, with varied aspects, on neutral or slightly acidic, nutrient-rich soils. The tree layer has a low cover, up to 10-15%, and its composition more frequently includes *Picea abies*, *Sorbus aucuparia* subsp. *aucuparia*, and *Betula pendula*. The shrub layer, characterized by high cover (ranging between 35 - 60%) is dominated by the differential species - *Spiraea chamaedryfolia*, alongside which *Vaccinium myrtillus*, *Lonicera xylosteum*, *Sambucus racemosa*, *Salix caprea*, etc. also occur sporadically. The herbaceous layer is more diverse, has variable coverage, ranging between 35 and 65% and includes numerous species: *Epilobium angustifolium*, *Poa nemoralis*, *Gentiana asclepiadea*, *Euphorbia amygdaloides*, *Solidago virgaurea*, etc. Most of the species in floristic composition have Eurasian and European areal (70%). Also, in the floristic composition, there is highlighted the higher frequency of some diagnostic species of the alliance Epilobion angustifolii (e.g. *Epilobium angustifolium*, *Calamagrostis arundinacea*, *Luzula luzuloides*, etc.), the order Galeopsio-Senecionetalia sylvatici (*Stachys sylvatica*, *Cirsium oleraceum*, etc.) and the class Epilobietea angustifolii (*Senecio ovatus*, *Fragaria vesca*, *Gnaphalium sylvaticum*, etc.). Along with these, the

investigated phytocoenoses also include species from deciduous or mixed forests of class Querco - Fagetea (*Dryopteris filix-mas*, *Poa nemoralis*, *Scrophularia nodosa*, *Fagus sylvatica* juv., etc.), from coniferous forests classified in class Vaccinio - Piceetea (*Oxalis acetosella*, *Campanula abietina* etc.), or from semi-natural communities of the class Galio - Urticetea (*Veronica urticifolia*, *Salvia glutinosa*, *Leucanthemum vulgare*, etc.).

Cluster 2. As. *Rubetum idaei* Gams 1927

Diagnostic species: *Acer pseudoplatanus*, *Agrostis capillaris*, *Cirsium erisithales*, *Cruciata glabra*, *Euphorbia amygdaloides*, *Festuca rubra*, *Galeopsis speciosa*, *Hypericum maculatum*, *Lonicera xylosteum*, *Luzula sylvatica*, *Mycelis muralis*, *Myosotis sylvatica*, *Polygonatum verticillatum*, *Ribes uva-crispa*, *Rubus idaeus*, *Salix caprea*, *Salvia glutinosa*, *Sambucus racemosa*, *Senecio ovatus*.

Constant species: *Digitalis grandiflora*, *Dryopteris filix-mas*, *Gentiana asclepiadea*, *Gnaphalium sylvaticum*, *Luzula luzuloides*, *Origanum vulgare*, *Oxalis acetosella*, *Picea abies*, *Scrophularia nodosa*, *Sorbus aucuparia*, *Spiraea chamaedryfolia*, *Stachys sylvatica*, *Veronica urticifolia*.

Dominant species: *Rubus idaeus*.

The association comprises shrub communities dominated by *Rubus idaeus*, developed on nutrient-rich soils. They frequently occur in the studied region, on deforested areas and in forest clearings, on slopes with inclinations varying between 15-45º, with various aspects. The shrub layer presents high cover, ranging between 65-85%, and is dominated by *Rubus idaeus*, alongside which *Sambucus racemosa*, *Viburnum opulus*, *Salix caprea*, *Ribes uva-crispa*, *Spiraea chamaedryfolia*, *Lonicera xylosteum* also occur sporadically, or rare juvenile specimens of *Picea abies* or *Sorbus aucuparia*. The more species-rich herbaceous layer presents variable cover, ranging between 10 and 40% and includes numerous species, as: *Fragaria vesca*, *Galeopsis speciosa*, *Poa nemoralis*, *Salvia glutinosa*, *Oxalis acetosella*, *Luzula luzuloides*, *Digitalis grandiflora*, *Cruciata glabra*, *Myosotis sylvatica*, *Impatiens noli-tangere*, etc. Floristic composition mainly includes species with Eurasiatic and European areal. Some species characteristics for the alliance Sambuco racemosae - Salicion capreae and the order Sambucetalia racemosae (*Sorbus aucuparia*, *Sambucus racemosa*, *Betula pendula*, *Urtica dioica*, etc.), as well as for the class Epilobietea angustifolii (*Galeopsis speciosa*, *Salix caprea*, *Corylus avellana*, *Senecio ovatus*, *Epilobium angustifolium*, *Gnaphalium sylvaticum*, *Eupatorium cannabinum*) present high constancy indices. The investigated plant communities also include species from class Querco - Fagetea (*Mycelis muralis*, *Euphorbia amygdaloides*, *Acer pseudoplatanus*, *Dryopteris filix-mas*, etc.), from coniferous forests classified in the Vaccinio - Piceetea class (*Picea abies*, *Calamagrostis arundinacea*, *Abies alba* juv., *Campanula abietina*, etc.), and from the tall-herb, semi-natural perennial vegetation on disturbed forest edges in Trifolio - Geranietea (*Gentiana asclepiadea*) or Galio - Urticetea classes (*Veronica urticifolia*, *Geranium robertianum*, etc.).

Cluster 3. As. *Salici - Alnetum viridis* Colic et al. 1962

Diagnostic species: *Aconitum degenii*, *Alnus viridis*, *Athyrium distentifolium*, *Cicerbita alpina*, *Cystopteris montana*, *Deschampsia cespitosa*, *Lonicera nigra*, *Ranunculus montanus* subsp. *pseudomontanus*, *Salix silesiaca*, *Veronica officinalis*.

Constant species: *Deschampsia flexuosa*, *Epilobium angustifolium*, *Gnaphalium sylvaticum*, *Luzula luzuloides*, *L. sylvatica*, *Lycopodium selago*, *Picea abies*, *Salix caprea*, *Sorbus aucuparia*, *Vaccinium myrtillus*, *Vaccinium vitis-idaea*, *Veratrum album*.

Dominant species: *Alnus viridis*.

The association *Salici - Alnetum viridis* comprises phytocoenoses dominated by *Alnus viridis*, sporadically occurring in the subalpine belt (along streams), on the eastern slopes of the Călimani Mountains where it occupies steep and wet slopes. The shrub layer is compact, has a cover between 70 - 80% and is built up by *Alnus viridis*, and individuals of *Salix silesiaca*, *Picea abies*, *Sorbus aucuparia*, *Spiraea chamaedryfolia*, etc. The herbaceous layer presents low cover (5 - 15%) and reduced diversity, and includes several species such as: *Deschampsia cespitosa*, *Calamagrostis villosa*, *Veratrum album*, *Valeriana tripteris*, *Epilobium angustifolium*, etc. In the floristic composition, including a mix of circumpolar, Central European and Eurasian species, higher frequencies present some species characteristic of the alliance Alnion viridis (*Salix silesiaca*, *Lonicera nigra*, etc.), order Alnetalia viridis and class Betulo carpaticae - Alnetea viridis (*Cicerbita alpina*, *Athyrium distentifolium*, etc.). Because the phytocoenoses of the association come into contact with junipers communities or coniferous forests, the floristic composition also includes a series of species from the Vaccinio - Piceetea class (e.g. *Picea abies*, *Deschampsia flexuosa*, *Campanula abietina*, *Homogyne alpina*, etc.).

Cluster 4. As. *Rhododendro myrtifolii – Pinetum mugo* Coldea 1991

Diagnostic species: *Calamagrostis villosa*, *Pinus mugo*.

Constant species: *Deschampsia flexuosa*, *Juniperus communis* subsp. *nana*, *Luzula luzuloides*, *Rhododendron myrtifolium*, *Sorbus aucuparia*, *Vaccinium myrtillus*, *Vaccinium vitis-idaea*.

Dominant species: *Pinus mugo*.

The communities with *Pinus mugo* were identified on the eastern slopes of the Căliman Izvor and Călimanul Cerbului peaks, where it forms a continuous band at 1800 – 1900 (1950) m altitude. The association is installed on slopes with different inclinations (between 5 and 20º or on flat lands), on acidic soils, poor in nutrients. They are included in priority habitat type 4070* *Pinus mugo* and *Rhododendron hirsutum* (*Mugo - Rhododendretum hirsuti*) thickets, with the mention that *R. hirsutum* is replaced in the Carpathians by the vicariant species *R. myrtifolium*.

The shrub layer, characterized by high cover (ranging between 80 and 95%), is dominated by *Pinus mugo*, and include also individuals of *Juniperus communis* subsp. *nana* or specimens of *Picea abies* or *Sorbus aucuparia* (reduced to shrub size). The sub-shrub layer is generally well represented, presenting covers of up to 25%, its composition more frequently including: *Vaccinium myrtillus*, *Rhododendron myrtifolium*, *Vaccinium vitis-idaea* and *Vaccinium gaultherioides*. The herbaceous layer is the most diverse, presenting variable cover (ranging between 20 and 55%) and is formed, besides the diagnostic species *Calamagrostis villosa*, by some other species such as: *Luzula luzuloides*, *Campanula abietina*, *Homogyne alpina*, *Deschampsia flexuosa*, *Hypericum richeri* ssp. *grisebachii* etc. In the floristic composition, high frequency presents the diagnostic species of alliance Pinion mugo and of the orders Junipero - Pinetalia mugo (*Juniperus communis* subsp. *nana*, *Rhododendron myrtifolium*) and Piceetalia excelsae (*Luzula luzuloides*, *Deschampsia flexuosa*), and especially of the class Roso pendulinae-Pinetea mugo (*Homogyne alpina*, *Lycopodium selago*, *Sorbus aucuparia*, etc.). Besides these, the investigated phytocoenoses also harbor species from the (sub)alpine

dwarf-shrubs communities within class Loiseleurio - Vaccinietea (*Vaccinium gaultherioides*, *Vaccinium vitis-idaea*), or species infiltrated from the alpine meadows from class Juncetea trifidi (*Hieracium alpinum*, *Juncus trifidus*, *Antennaria dioica*, *Potentilla aurea* subsp. *chrysocraspeda*, etc.).

The *Pinus mugo* with *Rhododendron myrtifolium* communities are integrated in the Natura 2000 habitat - 4070* [Bushes with *Pinus mugo* and *Rhododendron hirsutum* (*Mugo-Rhododendretum hirsuti*), considered priority for conservation [Habitats Directive 92/43/EEC, 1992]. Among the main threats to the *Pinus mugo* communities there are: cutting, fires and tourism [SĂRĂȚEANU & al. 2022]. These high-altitude habitats are also considered particularly vulnerable to climate change [ŠVAJDA & al. 2011]. However, in Carpathians Mountains this habitat type was assessed as presenting an ecologically satisfactory status [BARANČOK & al. 2014] because it is sufficiently large in terms of area and distribution and presents a significant capacity of resilience to natural or human-induced disturbances. Also, in Romanian Carpathians a number of 24 Natura 2000 sites were designated to conserve these subalpine habitats [SĂRĂȚEANU & al. 2022] while in European Red List of Habitats (2016), this habitat type was assessed as Least Concern.

Cluster 5. As. *Rhododendro myrtifolii - Vaccinietum* Coldea et al. 1981

Diagnostic species: *Juniperus communis* subsp. *nana*, *Ligusticum mutellina*, *Rhododendron myrtifolium*, *Thymus alpestris*, *Vaccinium gaultherioides*.

Constant species: *Antennaria dioica*, *Campanula abietina*, *Campanula alpina*, *Deschampsia flexuosa*, *Hieracium alpinum*, *Homogyne alpina*, *Juncus trifidus*, *Juniperus communis* subsp. *nana*, *Potentilla aurea* subsp. *chrysocraspeda*, *Vaccinium gaultherioides*, *Vaccinium myrtillus*, *Vaccinium vitis-idaea*.

Dominant species: *Rhododendron myrtifolium*.

Association *Rhododendro myrtifolii - Vaccinietum* was identified at high altitudes, on the slopes of Căliman Izvor and Călimanul Cerbului peaks. It includes dwarf shrubs communities dominated by *Rhododendron myrtifolium* and various *Vaccinium* species, developed on moderately humid, acidic and nutrient-poor soils.

The floristic composition is characterized by a reduced number of species, more than half of these presenting circumpolar and alpine distribution. The shrub layer has a cover of 65 - 85% and includes few other dwarf-shrub species such as *Vaccinium myrtillus*, *Juniperus communis* subsp. *nana*, *Pinus mugo*, etc. The herbaceous layer is more consistent and includes several species: *Campanula alpina*, *Festuca supina*, *Nardus stricta*, *Luzula sudetica*, *Veratrum album*, etc. In the studied communities, higher frequencies were highlighted for diagnostic species of alliances Rhododendrion myrtifolii and Loiseleurio - Vaccinion, for the order Rhododendro - Vaccinietalia (*Ligusticum mutellina*, *Primula minima*, *Vaccinium gaultherioides*, etc.) and the class Loiseleurio - Vaccinietea (*Vaccinium myrtillus*, *Vaccinium vitis-idaea*, *Juniperus communis* subsp. *nana*, etc.). The association also comprises species from the vegetation of alpine meadows from class Juncetea trifidi (*Pulsatilla alba*, *Potentilla aurea* subsp. *chrysocraspeda*, *Juncus trifidus*, *Carex atrata*, etc.), from primary subalpine meadows on acidic soils classified in class Nardetea strictae (*Antennaria dioica*, *Nardus stricta*), or infiltrated from the communities of Vaccinio - Piceetea class (*Campanula abietina*, *Lycopodium selago*, *Deschampsia flexuosa*, *Luzula luzuloides*, *Pinus mugo*, etc.).

Cluster 6. As. *Campanulo abietinae - Juniperetum nanae* Simon 1966

Diagnostic species: *Campanula rotundifolia* subsp. *polymorpha*, *Hypochaeris uniflora*, *Juniperus communis* subsp. *nana*, *Vaccinium gaultherioides*, *Vaccinium vitis-idaea*.

Constant species: *Antennaria dioica*, *Anthoxanthum odoratum*, *Campanula abietina*, *Deschampsia flexuosa*, *Homogyne alpina*, *Juncus trifidus*, *Ligusticum mutellina*, *Luzula luzuloides*, *Picea abies* juv., *Rhododendron myrtifolium*, *Vaccinium myrtillus*.

Dominant species: *Juniperus communis* subsp. *nana*.

Phytocoenoses within *Campanulo abietinae - Juniperetum nanae* were identified in the subalpine belt of the Călimani Mountains, at high altitudes, including compact heaths dominated by *Juniperus communis* subsp. *nana*, occurring on moderately inclined slopes, moderately moist, acidic and nutrient-poor soils.

The floristic composition is species-poor, comprising a significant proportion of circumpolar, alpine and Carpathian - Balkan elements. The shrub layer is compact, with a cover of 80 - 95% and includes shrubs species such as: *Rhododendron myrtifolium*, *Vaccinium myrtillus*, *Pinus mugo*, *Vaccinium vitis-idaea*, etc. The herbaceous layer presents low cover (5 - 20%), and includes several species, such as: *Antennaria dioica*, *Homogyne alpina*, *Festuca supina*, *Nardus stricta*, *Luzula sudetica*, *Anthoxanthum odoratum*, *Pilosella aurantiaca* s.l. In floristic composition high frequencies present the diagnostic species of the alliances Juniperion nanae and Rhododendro - Vaccinion and order Vaccinio microphylli-Juniperetalia nanae (*Calamagrostis villosa*, *Vaccinium gaultherioides*), as well as for class Loiseleurio-Vaccinietea (*Vaccinium myrtillus*, *Vaccinium vitis-idaea*, etc.). In addition, the association also harbors species from the vegetation of alpine meadows classified in class Juncetea trifidi (*Juncus trifidus*, *Hypochaeris uniflora*, *Pulsatilla alba* subsp. *alba*, *Hieracium alpinum* s.l., etc.), or from the forests and dwarf pine stands within class Roso pendulinae - Pinetea mugo (*Deschampsia flexuosa*, *Lycopodium selago*, *Pinus mugo*, etc.).

Cluster 7. Ass. *Empetro - Vaccinietum gaultherioidis* Br.-Bl. in Br.-Bl. et Jenny 1926 corr. Grabherr in Grabherr et Mucina 1993

Diagnostic species: *Campanula alpina*, *Cetraria islandica*, *Empetrum hermaphroditum*, *Juncus trifidus*, *Thamnolia vermicularis*, *Vaccinium gaultherioides*.

Constant species: *Antennaria dioica*, *Deschampsia flexuosa*, *Hieracium alpinum*, *Juniperus communis* subsp. *nana*, *Ligusticum mutellina*, *Rhododendron myrtifolium*, *Vaccinium vitis-idaea*.

Dominant species: *Vaccinium gaultherioides*.

This association groups phytocoenoses dominated by nanophanerophyte species (*Vaccinium gaultherioides*) in the subalpine belt of Călimanul Cerbului and Căliman Izvor mountains, at high altitudes, installed on acidic and nutrient-poor soils. The floristic composition is characterized by a reduced number of species. The vegetation cover (including the lichen layer) varies between 75 - 95% and includes, besides the dominant species: *Vaccinium vitis-idaea*, *Juniperus communis* subsp. *nana*, *Festuca supina*, *Luzula sudetica*, etc. Most of the component species present circumpolar and alpine distribution (~ 70%). High frequencies were highlighted for some diagnostic species of the alliance Loiseleurio-Vaccinion, the order Rhododendro - Vaccinietalia and the class Loiseleurio - Vaccinietea (*Primula minima*, *Cetraria islandica*, *Vaccinium myrtillus*, *Thamnolia vermicularis*, etc.). The floristic composition includes also species from the vegetation of alpine meadows of the class Juncetea trifidi (*Juncus trifidus*, *Hieracium alpinum*, *Campanula alpina*, etc.).

Table 1. Synoptic table with fidelity (diagnostic species were considered only those with fidelity Phi coefficient value > 30 - multiplied by 100). The associations (groups) are: 1 - Ass. *Digitali ambigue - Calamagrostietum arundinaceae* subass. *spiraeetosum chamaedryfoliae*, 2 - Ass. *Rubetum idaei*, 3 - Ass. *Salici - Alnetum viridis*, 4 - Ass. *Rhododendro myrtifolii - Pinetum mugo*, 5 - Ass. *Rhododendro myrtifolii - Vaccinietum*, 6 - Ass. *Campanulo abietinae - Juniperetum*, 7 - Ass. *Empetro - Vaccinietum gaultherioidis*.

Group no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
No. of relevés	**6**	**7**	**5**	**5**	**5**	**5**	**7**
Spiraea chamaedryfolia	81.3	---	---	---	---	---	---
Cirsium oleraceum	79.3	---	---	---	---	---	---
Angelica sylvestris	79.3	---	---	---	---	---	---
Digitalis grandiflora	76.7	---	---	---	---	---	---
Gentiana asclepiadea	70	---	---	---	---	---	---
Betula pendula juv.	68	---	---	---	---	---	---
Trifolium repens subsp. *repens*	67.8	---	---	---	---	---	---
Hylotelephium maximum	67.8	---	---	---	---	---	---
Stachys sylvatica	63.6	---	---	---	---	---	---
Veronica urticifolia	59.4	---	---	---	---	---	---
Fagus sylvatica juv.	57.9	---	---	---	---	---	---
Scrophularia nodosa	57.9	---	---	---	---	---	---
Dryopteris filix-mas	57.9	---	---	---	---	---	---
Dactylis glomerata subsp. *glomerata*	54.6	---	---	---	---	---	---
Silene nutans subsp. *dubia*	54.6	---	---	---	---	---	---
Ajuga reptans	54.6	---	---	---	---	---	---
Solidago virgaurea subsp. *virgaurea*	54.6	---	---	---	---	---	---
Leucanthemum vulgare subsp. *vulgare*	54.6	---	---	---	---	---	---
Picea abies	45	---	---	---	---	---	---
Luzula luzuloides	32.4	---	---	---	---	---	---
Cicerbita muralis	---	91.7	---	---	---	---	---
Galeopsis speciosa	---	82.5	---	---	---	---	---
Rubus idaeus	---	78.9	---	---	---	---	---
Sambucus racemosa	---	77.8	---	---	---	---	---
Ribes uva-crispa	---	62.4	---	---	---	---	---
Viburnum opulus	---	62.4	---	---	---	---	---
Lonicera xylosteum	---	58.9	---	---	---	---	---
Acer pseudoplatanus juv.	---	54.3	---	---	---	---	---
Euphorbia amygdaloides	---	54.3	---	---	---	---	---
Polygonatum verticillatum	---	50.4	---	---	---	---	---

Myosotis sylvatica	---	50.4	---	---	---	---	---
Cruciata glabra	---	50.4	---	---	---	---	---
Festuca rubra	---	50.4	---	---	---	---	---
Agrostis capillaris	---	50.4	---	---	---	---	---
Cirsium erisithales	---	50.4	---	---	---	---	---
Hypericum maculatum	---	48	---	---	---	---	---
Salix caprea	---	47.5	---	---	---	---	---
Luzula sylvatica	---	39.6	---	---	---	---	---
Alnus viridis	---	---	100	---	---	---	---
Salix silesiaca	---	---	87.9	---	---	---	---
Cicerbita alpina	---	---	74.9	---	---	---	---
Athyrium distentifolium	---	---	74.9	---	---	---	---
Lonicera nigra	---	---	60.1	---	---	---	---
Aconitum degenii	---	---	60.1	---	---	---	---
Veronica officinalis	---	---	49.4	---	---	---	---
Ranunculus montanus subsp. *pseudomontanus*	---	---	46.1	---	---	---	---
Cystopteris montana	---	---	46.1	---	---	---	---
Deschampsia cespitosa	---	---	44.5	---	---	---	---
Pinus mugo	---	---	---	75.8	---	---	---
Ligusticum mutellina	---	---	---	---	61.8	---	---
Rhododendron myrtifolium	---	---	---	---	51.3	---	---
Thymus alpestris	---	---	---	---	46.1	---	---
Melampyrum saxosum	---	---	---	---	46.1	---	---
Juniperus communis subsp. *nana*	---	---	---	---	---	46.5	---
Hypochaeris uniflora	---	---	---	---	---	46.1	---
Campanula rotundifolia subsp. *polymorpha*	---	---	---	---	---	46.1	---
Vaccinium vitis-idaea	---	---	---	---	---	42.5	---
Thamnolia vermicularis	---	---	---	---	---	---	100
Cetraria islandica	---	---	---	---	---	---	100
Empetrum hermaphroditum	---	---	---	---	---	---	90.2
Vaccinium gaultherioides	---	---	---	---	---	---	54
Juncus trifidus	---	---	---	---	---	---	38
Campanula alpina	---	---	---	---	---	---	34.5
Poa nemoralis	68.8	55.5	---	---	---	---	---
Fragaria vesca	68.8	55.5	---	---	---	---	---
Calamagrostis arundinacea	67.4	41	---	---	---	---	---

Salvia glutinosa	53	42.8	---	---	---	---	---
Senecio ovatus	53	42.8	---	---	---	---	---
Epilobium angustifolium	39.3	43.8	---	---	---	---	---
Calamagrostis villosa	---	---	37.7	55	---	---	---
Homogyne alpina	---	---	37.3	37.3	---	---	---
Pulsatilla alba subsp. *alba*	---	---	---	---	60.1	---	47.5
Luzula sudetica	---	---	---	---	47.9	---	44.7
Festuca supina	---	---	---	---	42.9	42.9	42.9

Conclusions

The shrubs-dominated vegetation constitutes an important component in the landscape of investigated area. According to above presented research, seven well-delimited shrub communities (at the association level) were distinguished and contribute to the understanding of this vegetation type in Neagra Broşteni river basin. They were classified into seven phytosociological alliances, five orders and four vegetation classes. Three of the associations belong to Natura 2000 habitats: 4060 Alpine and Boreal heaths (*Empetro - Vaccinietum gaultherioidis*, *Rhododendro myrtifolii - Vaccinietum Coldea*, and *Campanulo abietinae - Juniperetum nanae*), and one to habitat 4080 Sub-Arctic Salix ssp. scrub (*Salici - Alnetum viridis*). The *Pinus mugo* with *Rhododendron myrtifolium* communities are integrated in the Natura 2000 habitat - 4070* Bushes with *Pinus mugo* and *Rhododendron hirsutum* (*Mugo-Rhododendretum* hirsuti), considered priority for conservation. Although *Pinus mugo* communities are threatened by a series of human-related activities or climate change, in Carpathians Mountains this habitat type was assessed as presenting an ecologically satisfactory status, and it is protected in numerous Natura 2000 sites.

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