VEGETATION OF NORWAY SPRUCE FORESTS (*Picea abies*) WITHIN THE APUSENI MOUNTAINS NATURAL FOREST HABITATS OF COMMUNITY INTEREST

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Abstract. The aim of this study is to identify and describe the mountain and subalpine spruce forests included in the priority natural habitats of the Vlădeasa Massif - Apuseni Mountains for protection purposes by declaring them special conservation areas. To achieve this aim, we put forward four objectives: identification of habitat types, finding plant associations, carrying out floristic inventory and ecological characterization of species, identification of forests with high conservation value, assessment of conservation status and potential threats, establishment of sustainable management and these habitats. We carried out an itinerary-based forest research based on four successive work stages: scientific documentation, field research, preliminary assessment, and final evaluation. In terms of results, we processed and analyzed scientific data on the structure of the habitat, floristic composition of the phytocoenosis, high conservation values identified, rare, relicts, endemic flora species, conservation status thereof, and potential threats. We draw two conclusions as synthesis of our work' results.

Key words: phytocoenoses; conservation; sustainability; endemic species; spruce forests.

INTRODUCTION

Habitats of community interest mean the vital space (place of life) necessary for the development of a species, population, biocoenoses, biome (groups of related biocoenoses) or ecosystems of major importance for the protection and conservation of nature in accordance with the Habitats Directive 92/43/CEE of 21.05.1992 [26, 60] transposed into Romanian legislation by the Government of Romania through Law 462/2001 [63] for the approval of the Government's Emergency Ordinance no. 236/2000 [61], by Government Decision no. 1284/2007 [64], Emergency Ordinance no. 57/2007 [65] on the regime of natural protected areas, conservation of natural habitats, flora and fauna, which stipulate detailed provisions regarding the establishment of the Natura 2000 Network and related sites management.

The aim of this paper is to describe the natural habitat of community interest 9410 Acidophilus *Picea abies* forests of the montane to subalpine levels (***Vaccinio-Piceetea***) which includes Norway spruce forests as well as mixed Norway spruce, Silver fir, and beech forests sharing the same type of herbaceous acidophilus flora (*Luzula sylvatica*, *Luzula luzuloides*, *Calamagrostis villosa*, *Deschampsia flexuosa*, *Homogyne alpina*, *Soldanella oreodoxa*, *Blechnum spicant*, *Vaccinium myrtillus*, *Lycopodium annotinum*).

In order to achieve the proposed goal, we set the following objectives:

- Identification of the types of natural, priority forest habitats of community interest in the European and Romanian version of the biome of the spruce forests of the Vlădeasa Mountains.
- Identification of plant associations and types of forest ecosystems containing high conservation values, rare, vulnerable, endangered, endemic, relict plant species included in natural habitats of community interest.
- Establishing the biodiversity of the Natura 2000 habitat code 9410 acidophilus *Picea abies* forests in general and of the *Soldanello oreodoxae-Piceetum* association in particular with the highlighting and ecological characterisation of the species in terms of bioform type, phytogeographical elements and ecological index categories.
- Identification of forests with high conservation value and distribution thereof in the territory within the coniferous forest biome.
- Assessment of conservation status, potential threats (stressors), establishment of sustainable management of habitats ecosystems containing forests with high conservation value.

For the scientific documentation on the current state of knowledge, we consulted the scientific works containing more or less congruent information in terms of the definition and classification of the types of natural habitats containing forests with high conservation value; these works belong to the authors: Biriș *et al*. (2002) [4], Burescu (2017) [6], Burescu (2018) [7], Burescu *et* Morar Burescu (2019) [8], Burescu *et al*. (2022) [9], Candrea Bozga *et al*. (2009) [10], Ciocârlan (2009) [11], Coldea *et* Cristea (2021) [17], Doniță *et al*. (2005) [27], Drăgulescu *et al*. (2007) [28], Gafta *et al*. (2008) [30], Ioraș *et* Abrudan (2007) [32], Jennings *et al*. (2003) [33], Lazăr *et al*. (2007) [34], Mucina *et al* [36], Neblea *et* Dragomir (2015) [37], Resmeriță (1970) [41], Schneider *et* Drăgulescu (2005) [45], Reif *et al*. (2022) [40], Stanciu *et al*. (2004) [50], Stăncioiu (2008) [47], Stăncioiu *et al*. (2008) [48], Vlad *et al*. (2013) [56], [13, 15, 16, 29, 31, 49, 54].

We found information about the biodiversity of some mountain and subalpine forest ecosystems in the works of Coldea *et* Wagner (1997) [12], Doniță *et* Gafta (1992) [25], Sanda *et al*. (2005, 2007) [42, 43], taxonomic classification on *Soldanella* species by Zhang *et al*. (2001, 2002, 2004) [57-59], Steffen *et* Kadereit (2014) [51], Bellino *et al*. (2015) [2],

Štubňová *et al*. (2017) [52], Valachovič *et al*., (2019) [55] and with regard to the species included in the red lists we reviewed the works of Angelstam *et al*. (2004) [1], Bilz *et al*. (2011) [3], Boșcaiu *et al*. (1994) [5], Coldea *et al*. (2008) [14], Danciu *et al*. (2007) [21], Dihoru *et* Negrean (2009) [22], Oltean *et al*. (1994) [38], Radu (2001) [39], Schulze *et* Mooney (1993) [46].

MATERIALS AND METHODS

We conducted our research in the timeframe 2022-2023 in the Vlădeasa Massif, Valea Drăganului Basin, Valea Sebișelului Basin, on a total afforested area of 820 km^2 and 16,000 ha respectively, managed by the Remeți Forest District, the Bihor County Forest Administration, Romania.

We carried out the habitat selection by identifying the phytocoenoses characterizing the vegetal association subscribed to the habitat, considering the dominant and characteristic ecological and phytosociological plant species, by recognizing the characteristics of the site in terms of geographical location, altitude, relief, rock, soil and climate.

The processing of the clusters in the view of the phytosociological dendrogram was carried out on the computer with the helps of *Past 4.03* program.

In order to attain the set objectives, we phased our research works in four successive staged, as follows:

1. The first stage consists in consulting the forest management, forest vegetation maps, maps of protected areas and published scientific works on the types of natural habitats, and the red lists for the protection of rare species.
2. The second stage refers to the preliminary evaluation through which the forest areas containing high conservation values (rare, vulnerable, relict, endemic species) are considered in the study as presumptive spruce forests that can be included in natural habitats of community interest.
3. The third stage consists in the field research of the forest areas containing high conservation values and that are classified as suitable for inclusion in the natural habitats of community interest.
4. The fourth stage refers to the full and final assessment and has as its objective the definitive establishment of classified forest areas that contain high conservation values (HCVFs) and which are included in a table that includes all types of natural forest habitats found in the researched territory.

After full evaluation of the high conservation value forest areas, the process continues with the management phase and the habitat monitoring phase.

RESULTS

Following the research we carried out, the surfaces of the spruce forests included in the natural forest habitat of community interest Natura 2000: 9410 *Picea abies* acidophilic forests of the montane to subalpine levels (***Vaccinio-Piceetea***) were analyzed floristically and ecologically.

This type of habitat clusters the spruce forests spread in the upper and subalpine mountain floors of the Apuseni Mountains [35] and which grows on a substrate made of siliceous rocks overlain by superficial, skeletal, highly acidic, oligobasic and moist soils. It grows on the ridges and ridges of strongly inclined slopes with different exposures, on sites at altitudes ranging between 1,400-1,700 m, characterized by a cold climate T = 4.0-1.5°C with abundant rainfall P = 1,000-1,200 mm [18].

Vegetation of this habitat gathers in its tree layer and in various shares the main species: *Picea abies*, *Abies alba* and more rarely *Fagus sylvatica* and more frequently the disseminated ones: i.e. *Sorbus aucuparia* and *Acer pseudoplatanus*. The shrub layer is missing under the dense spruce stands or is poorly developed under the less dense stands and consists in *Sambucus racemosa*, *Salix silesiaca*, *Juniperus communis* subsp. *alpina*, *Lonicera nigra*, *Rosa pendulina* and rare bushes of *Alnus viridis* (*Alnus alnobetula*) and *Ribes uva-crispa.*

The usually well-developed herbaceous layer consists of a large number of acidophilic species of the mull and mull-moderate flora, estimated at roughly 50-60 taxa, of which faithful species with a high frequency in the habitat (constancy) between 61-100% are present: *Soldanella oreodoxa*, *Luzula sylvatica*, *Hieracium rotundatum*, *Homogyne alpina*, *Calamagrostis villosa*, *Vaccinium myrtillus*, *Oxalis acetosella*, *Gymnocarpium dryopteris* followed by accessory species with a constancy ranging between 41-60% such as: *Deschampsia flexuosa*, *Gentiana asclepiadea*, *Polygonatum verticillatum*, *Dryopteris dilatata*, *Blechnum spicant*, *Huperzia selago*, *Lycopodium annotinum*, *Leucanthemum waldsteinii*. The moss layer with variable development under the trees stand covers the ground in clumps of different sizes in plant communities *Soldanello oreodoxae-Piceetum*, *Hieracio rotundati-Piceetum* and completely in the association *Sphagno girgensohnii-Piceetum* with species of *Polytrichum juniperinum* (ADm=18%), *Dicranum scoparium* (ADm=24,5%), *Rhitidiadelphus triquetrus* (ADm=5%), *Hylocomium splendens* (ADm=6%), *Sphagnum girgensohnii* (ADm=73,2%).

The Natura 2000 European Habitat 9410 *Picea abies* acidophilic forests of the montane to alpine levels (***Vaccinio-Piceetea***) identified and researched by us corresponds to four types codified in Romania in the Apuseni Mts., namely: R4203 Southeast Carpathian forests of Norway spruce (*Picea abies*) and fir (*Abies alba*) with *Soldanella hungarica*; R4206 Southeast Carpathian forests of Norway spruce (*Picea abies*) and fir (*Abies alba*) with *Hieracium rotundatum*; R4208 Southeast Carpathian forests of Norway spruce (*Picea abies*) and fir (*Abies alba*) with *Luzula sylvatica*; R4210 Southeast Carpathian forests of Norway spruce (*Picea abies*) with *Sphagnum girgensohnii* according to Doniță *et al*. (2005) [27], whose acidophilic, mostly

circumpolar and alpine flora consists in the associations *Soldanello oreodoxae-Piceetum*, *Hieracio rotundati-Piceetum* and *Sphagno girgensohnii-Piceetum* (Table 1).

Soldanello oreodoxae-Piceetum Coldea et Wagner 1998 corr. Coldea 2015 (Syn.: *Piceetum subalpinum austrocarpaticum* Borza 1959) in the Vlădeasa Massif, it occupies lands with moderate to steep slopes, on slopes with predominantly western exposures at altitudes ranging between 1,200-1,600 m, at the border with the Alpine plain on volcanic rocks, crystalline shale with rock spring on the surface in a share of 10-20%. The soil is rich in mull and moder humus, with a pH of 5.2-5.8. We identified the phytocoenoses of the *Soldanello oreodoxae-Piceetum* in the geographical area surveyed in the locations: Făgete Mountain, Micău Mountain, Șutanu spring, Muncei ridge, Poiana Drăgoteanului, Gruiu Ursului, Chenț spring, Boceasa Mountain, Cetățile and Moara Dracului waterfall, Upper basin of Zârna Valley, Upper basin of Crăciun valley – Nimăiasa spring, Manului spring.

Floristic structure and composition

The arborescent species *Picea abies* dominates and builds the association ADm=50.3%, K=V and endemic to the Apuseni Mts. element *Soldanella oreodoxa* is characteristic of the association with ADm=5.33% and a maximum constancy (K=V). Along with the aforementioned the characteristic and differential species for the alliance ***Piceion excelsae*** coexist: *Calamagrostis villosa, Homogyne alpina, Luzula sylvatica*, *Gentiana asclepiadea*, *Gymnocarpium dryopteris*, *Hieracium transsilvanicum*, *Leucanthemum waldsteinii*, *Phegopteris connectilis*, *Ranunculus platanifolius*, order ***Piceetalia excelsae***: *Deschampsia*

Table 1. Montane and subalpine forest habitat types of community interest identified in the Vlădeasa Massif, Apuseni Mts.

Habitats			Plant associations	Type of forest ecosystem	Categories of forests with high conservation value	Location
Habitats codes according to Directive 92/43 EEC	**For Romania code**	**Palaearctic Code**				
9410 Acidophilus *Picea* forests of the montane to subalpine levels (***Vaccinio-Piceetea***)	R4203. Southeast Carpathian forests of Norway spruce (*Picea abies*) and fir (*Abies alba*) with *Soldanella oreodoxa*	42.21626 Carpathian subalpine *Soldanella* spruce forest	*Soldanello oreodoxae-Piceetum* Coldea et Wagner 1998 corr. Coldea 2015	1136 1157	HCVF 1.2, 1.3, 3, 4.1, 4.2	Remeți Forest District, Management Unit I Boceasa, compartments: Ua9D, Ua76B, Ua84E, Ua104C, Ua105, Ua107C, Ua130E, Ua140A, Făgete Mountain, Micău, Vlădeasa, Muncei, Poiana Drăgoteanului, Gruiu Ursului, Chenț.
	R4206. Southeast Carpathian forests of Norway spruce (*Picea abies*) and fir (*Abies alba*) with *Hieracium rotundatum*	42.21623 Carpathian high montane *Hieracium* spruce forest	*Hieracio rotundati-Piceetum* Pawlowski et Br.-Bl. 1939	1234 3256	HCVF 1.2, 1.3, 3, 4.1, 4.2	
	R4208. Southeast Carpathian forests of Norway spruce (*Picea abies*) and fir (*Abies alba*) with *Luzula sylvatica*	42.21628 Carpathian *Luzula sylvatica* spruce forest	*Hieracio rotundati-Piceetum* Pawlowski et Br.-Bl. 1939 (Syn.: *Luzulo sylvaticae-Piceetum* Wraber 1953)	1237 2237	HCVF 1.2, 1.3, 3, 4.1, 4.2	
	R4210. Southeast Carpathian forests of Norway spruce (*Picea abies*) with *Sphagnum girgensohnii*	42.2131 Carpathian peat moss spruce forest	*Sphagno girgensohnii-Piceetum* Kauch 1954	1268	HCVF 1.2, 1.3, 3, 4.1, 4.2	Valea Drăganului valley with the tributaries Zârna Valley, Moara Dracului stream, Crăciunului Valley – Nimăiasa Stream, Ciripa Valley, Iadului Valley with tributary Cârligate Valley-4 brazi cabin

Notes: The classification by forest ecosystem types 1136 (Subalpine spruce with *Oxalis-Soldanella*), 1157 (Subalpine spruce with *Vaccinium-Polytrichum*), 1234 (Spruce with *Calamagrostis-Luzula*), 3256 (Spruce with *Vaccinium*), 1237 (European beech-Norway spruce with *Luzula sylvatica*), 2237 (Norway spruce-Silver fir with *Luzula sylvatica*), 1268 (Norway spruce with *Polytrichum*), was done according to the Romanian typological system elaborated by Doniță *et al*. (1990) [24], Doniță *et* Gafta (1992) [25]. High conservation value forests (HCVF) were classified by five distinct categories after processing the practical guidelines developed by Stanciu *et al*. (2004) [50], Vlad *et al.* (2013) [56] as follows: HCVF 1.2 Forests containing rare, threatened, endangered or endemic species; HCVF 1.3 Forests containing endemic and relict species; HCVF 3 Secular virgin forests where rare, threatened, endangered ecosystems are located or contain rare plant associations; HCVF 4.1 Forests with a special role in protecting drinking water sources or in preventing floods with excessive alluvium transport; HCVF 4.2 Forest with an important role in controlling soil erosion.

Figure. 1. *Soldanello oreodoxae-Piceetum* association. Original Picture, Muncei peak (on the edge of subalpine plains) (27.05.2022) 46°41'371"N, 22°38'966"E

flexuosa, *Luzula luzuloides*, *Lycopodium annotinum*, *Sphagnum girgensohnii*, *Dryopteris dilatata*, *Juniperus communis* subsp *alpina*, *Calamagrostis arundinacea*, class ***Vaccinio-Piceetea***: *Campanula abietina*, *Huperzia selago*, *Oxalis acetosella*, *Pinus mugo*, *Gentiana punctata*, *Vaccinium myrtillus*, *Vaccinium vitis-idaea*, *Veronica officinalis*, *Athyrium filix-femina*, *Sorbus aucuparia*, *Blechnum spicant*, *Lonicera nigra*, *Abies alba*, *Daphne mezereum*, *Streptopus amplexifolius*, *Salix silesiaca*, *Laserpitium krapfii* (see Table 2). Along with the characteristic species, in the phytocoenosis a small number of species migrated from the classes ***Querco-Fagetea***: *Fagus sylvatica*, *Anemone nemorosa*, *Lamium galeobdolon*, *Hypericum montanum*, *Veronica urticifolia*, *Polystichum aculeatum*; ***Nardo-Callunetea***: *Nardus stricta*, *Festuca rubra*, *Crocus heuffelianus*, *Luzula multiflora*, ***Epilobietea angustifolii***: *Epilobium angustifolium*, *Senecio germanicus*, *Sambucus racemosa*, *Rubus idaeus*.

The morphology of the phytocoenosis is tetrastratified (Fig. 1). The tree layer is dominated by *Picea abies* with an average height of 20 m and an average diameter of 35 cm, accompanied by rare specimens of *Sorbus aucuparia*, *Abies alba*, *Fagus sylvatica*. The undershrub consists of less frequent specimens, reduced in number of *Juniperus communis subsp. alpina, Pinus mugo*, *Salix silesiaca* and *Sambucus racemosa*. The better developed subshrub and herbaceous sinuzia consists of *Vaccinium myrtillus*, *Vaccinium vitis-idaea*, *Rubus idaeus*, *Luzula sylvatica*, *Homogyne alpina*, *Oxalis acetosella*, *Dryopteris dilatata*. Moss synusiae consists of *Sphagnum girgensohnii, Polytrichum strictum, Polytrichum juniperinum* and *Rhytidiadelphus triquetrus* within a compact living soil cover of a 15% coverage rate.

The dendrogram of the association (Fig. 2) suggests a high degree in the floristic composition, but also a certain diversity, the similarity index values ranging 0.3 to 1.0.

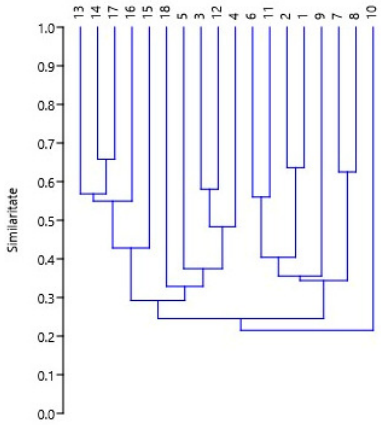

Figure 2. *Jaccard* similarity index of the *Soldanello oreodoxae-Piceetum* association for the Apuseni Mts.

Vegetation dynamics

Since we refer to a primary plant association of a climax nature, it is in a balance relationship with environmental factors, therefore the phytocoenoses of this association remain stable for a long time (thousands of years) and evolve so slowly that this process cannot be quantified in space, provided they are not affected by cataclysms (e.g. earthquakes, volcanic eruptions, fires, windfalls, massive insect attacks).

Economic importance

Norway spruce (*Picea abies*) forests with *Soldanella oreodoxa* are not important in terms of wood mass production. The phytocoenoses of the association subjected to research in the Vlădeasa Massif are rare, natural ecosystems, endangered and classified from a forestry standpoint in Group I forests - categories 1-2c (located around alpine and subalpine plains with widths ranging between 100-300 m depending on the slope and nature of the terrain (functional type II (TII = Forests with special protection functions in heavy seasonal conditions and stands for which wood harvesting by usual treatments is not indicated: 1.2.a (Forest with soil protection functions located on cliffs, gullies and on lands with deep erosion, with active landslides as well with large slopes (TII)); 1.3.a (Forests with protective functions

against climatic, industrial and harmful factors in the steppe and silvosteppe (TII)); 1.4.a (Forests with recreational functions specially arranged for recreational purposes (forest-park) (TII)); 1.5.f (Forest of scientific interest for the protection of the gene pool, the forest eco-pool as well as for the protection of natural monuments (TII)); 1.5.g (Forest intended for scientific research (TII)); 1.5.h (Forests established in seed reserves (TII));1.5.i (Forest intended for the protection of rare fauna species (TII));1.5.j (Secular, virgin and quasi-virgin forests of special value (TII));1.5.k (Dendrological forests and arboretums (TII)) [23]. Only conservation cutting is applied in stands in such forests.)), 1-3f (Forests located at high altitude in very difficult regeneration conditions (frost holes, sites with cold winds). Functional type II), 1-1c (Forests located on the slopes of rivers, streams in mountain areas that feed reservoirs (Functional type IV (Forests with special protective functions. In these stands conservation cutting is applied for gardening and other but not restrictive treatments)), 1-5j (Secular virgin and semi-virgin forests of special value (Functional type II)), forest vegetation with critical environmental, climatic, anti-erosion services (HCVF 4.1 (Forests with a role in the protection of drinking water sources and catchment in reservoirs), 4.2 (Forests with a role in the anti-erosion protection of the soil on the cliffs, scree, degraded lands) [50, 56], drinking water sources and intakes in the Floroiu reservoir, Valea Drăganului hydrographic basin, with a volume of 400,000 m^3.

Protection and conservation of nature

Southeast Carpathian forests of Norway spruce (*Picea abies*) forests with *Soldanella hungarica* code R4203 contain natural, rare ecosystems located in upper altitudinal forests and surviving in difficult living conditions. They are high conservation value forests because of the rare, endangered, vulnerable, relict, endemic species growing in them (*Soldanella oreodoxa*, *Gentiana punctata*, *Trollius europaeus*, *Heracleum palmatum*, *Ranunculus platanifolius*, *Aconitum callibotryon*, *Aconitum degenii* (*Aconitum variegatum* subsp. *paniculatum*) *Aconitum vulparia*, *Corallorrhiza trifida*, *Streptopus amplexifolius, Blechnum spicant*, *Asplenium viride*, *Adenostyles alliariae* subsp. *kerneri*) included in the natural habitats of community interest Natura 2000: 9410 *Picea abies* acidophilic forests of the montane to subalpine levels (***Vaccinio-Piceetea***); EMERALD: 142-21 Alpine and Carpathian subalpine spruce forest; PAL.HAB: 42.21626 Carpathian subalpine *Soldanella* spruce forest, which must be protected by declaring special conservation areas, Doniță *et al*. (2005) [27], Gafta *et al*. 2008 [30].

The belonging of the surveyed territory to the temperate climate is substantiated by the overwhelming share in the spectrum of bioforms of hemicryptophytes (56.9%) followed by phanerophytes (17.7%) which have the greatest coverage and instill the physiognomy of the *Soldanello oreodoxae-Piceetum* association (Fig. 3). Geophytes (12.6%), chamaephytes (7.6%) and bryophytes (5.1%) are also present but in insignificant shares.

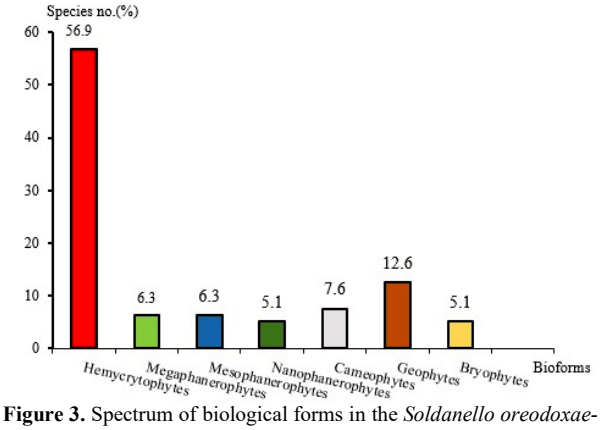

Figure 3. Spectrum of biological forms in the *Soldanello oreodoxae-Piceetum* association

The background of the floristic elements (Fig. 4) is dominated by circumpolar and boreal species (31.7%) followed by eurasian (12.6%), european and central european (11.4%). Alpine elements consist in alpine-carpatho-balkan species (7.6%), arctic-alpine (3.8%), alpine-european (6.3%), central alpine-european (1.3%). Endemic species are present in a share of 6.3%, carpatho-balkan elements share is 2.5% while cosmopolitan species share is only 5.1%.

The ecological indices (Fig. 5) regarding soil moisture highlights the preponderance of mesophilic (60%) and meso-hygrophilic (21.3%) species. In terms of air temperature, the microthermal (57.3%), micro-mesothermal (16%) along with eurythermal (16%) species are the ones.

The chemical reaction of the soil favours the development of acid-neutrophils and euriionic species (24%) followed by acidophiles (22.7%), mild acid-neutrophils (17.3%) and strong acidophiles (12%) (Table 3).

High conservation values

In the biome of this habitat, afforested areas (compartments) containing high conservation values belonging to HCVF category 1.1 included in the site ROSCI0016 *Pinus mugo* botanical reserve on Buceasa Peak (1,792 m), there were identified species belonging to: HCVF 1.2 category - rare, threatened, endangered species: *Angelica archangelica*, *Arnica montana*, *Adenostyles alliariae* subsp. *kerneri*, *Athyrium distentifolium*, *Allium schoenoprasum* subsp. *sibiricum*, *Gentiana punctata*, *Leucojum vernum*, *Ranunculus platanifolius*, *Saxifraga rotundifolia* subsp. *heucherifolia*, *Streptopus amplexifolius*, *Soldanella oreodoxa, Swertia punctata*, *Vaccinium gaultherioides*; HCVF 1.3, category - relict tertiary species: *Blechnum spicant*, *Sanicula europaea*; glacial relicts species: *Dryopteris cristata*; endemic species: *Aconitum moldavicum*, *Aconitum vulparia* subsp. *lasianthum*, *Heracleum palmatum*, *Phyteuma vagneri*, *Leucanthemum waldsteinii*, *Symphytum cordatum*, *Dentaria glandulosa, Soldanella oreodoxa*.

From the HCVF category 3 - Secular virgin forests in endangered ecosystems, rare plant associations of which we mention those identified in Management unit I Boceasa, compartments 117E, 123C, 123D, 124D, 104C and classified as forest vegetation in Group I, Subgroup 1.3 Forests with a protective function against climatic factors that survive in very difficult life and regeneration conditions 1.3.f. Subgroup 1.5. Forests of scientific interest and protection of the gene pool and forest eco-pool 1.5c. 1.5 days 1.5i. Doniță *et al*. (2006) [23].

Conservation status and potential threats

Protection of these forests is partially guaranteed by the inclusion of some of them in the protected area ROSCI0016 with an area of 19 ha but which needs to be extended to an area of 543.7 ha in a share of 10% of the area of 489 ha contained in Management unit I Boceasa, Burescu (2018) [7]. In accordance with the provisions of the Practical Guidelines Stanciu *et al*. (2004) [50], Vlad *et al*. (2013) [56] and Technical Regulations No. 103 [62] for the development of forests which provide for an absolute protection by prohibiting forestry works of any type, grazing and animal transit and human traffic with motor vehicles through the habitat and by prohibiting harvesting of forest products such as fruits and medicinal herbs.

Among the potential threats we mention:

1. Changing the functional type of treatment for Type I forests with special nature protection functions (1.5.a, 1.5.c, 1.5.d, 1.5.e) is prohibited without the approval of the competent bodies provided by Law 462/2001 [63], Government Emergency Ordinance No. 57/2007 [65] on the regime of protected areas, conservation of natural habitats and of flora and fauna;
2. Burning the vegetation on the neighboring lands that make it possible for the fire to spread in the protected areas as well;
3. Damage caused by phytophagous insects *(Ips typographus*), parasitic fungi (*Lophodermium pinastri*) can generate abnormal drying in Norway spruce forest stands.

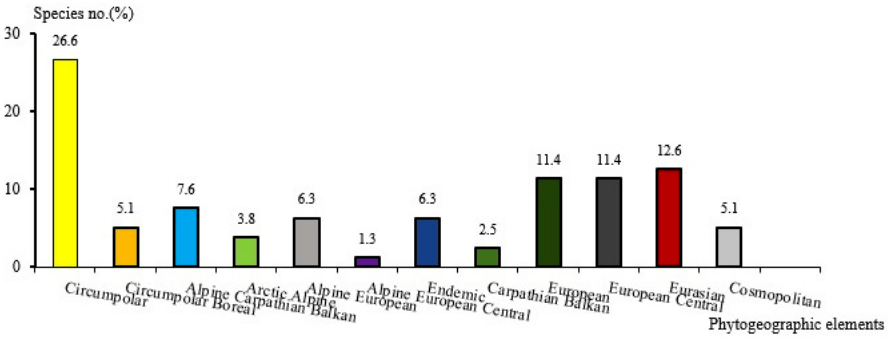

Figure 4. Distribution spectrum of phytogeographical elements in the *Soldanello oreodoxae-Piceetum* association

Table 3. Ecological indices for the *Soldanello oreodoxae-Piceetum* association

Ecological indices		1	1.5	2	2.5	3	3.5	4	5	0	Total species
Soil Moisture	Sp. No	-	-	2	5	24	21	16	1	6	75
	%			2.7	6.7	32	28	21.3	1.3	8	100
Air Temperature	Sp.No.	2	4	25	18	11	1	2	-	12	75
	%	2.7	5.3	33.3	24	14.7	1.3	2.7	-	16	100
Chemical Reaction of the Soil	Sp.No.	9		17		18		13	-	18	75
	%	12		22.7		24		17.3	-	24	100

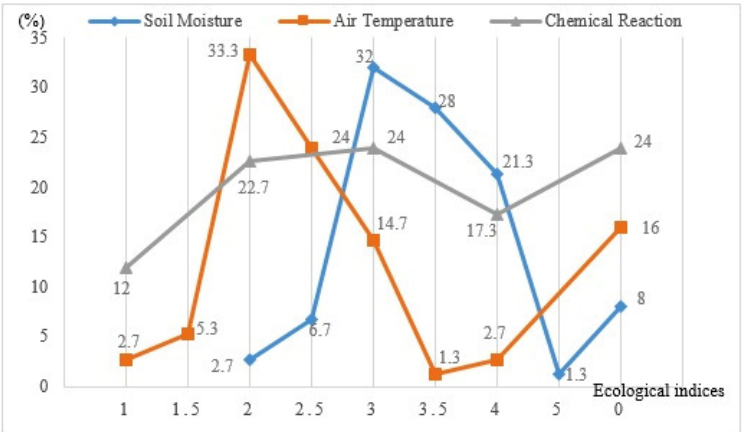

Figure 5. Diagram of ecological indices for the *Soldanello oreodoxae-Piceetum* association

Table 2. *Soldanello oreodoxae-Piceetum* Coldea et Wagner 1998 – corr. Coldea 2015

BIOFORMS	PHYTOGEOGRAPHIC ELEMENTS	MOISTURE	TEMPERATURE	SOIL REACTION	Survey no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	K (Frequency)	ADm (Abudence-Dominance)
					Altitude (m)	1285	1301	1652	1685	1709	1388	1461	1430	1373	1405	1395	1675	1500	1600	1250	1550	1451	1450		
					Exposure	NV	V	SE	-	N	NV	NV	V	N	E	E	S	NV	N	S	NE	NV	NE		
					Slope (°)	8 10	8 10	4 8	-	30 32	8 15	20 32	10 25	8 10	35 40	8 10	8 16	30	25	50	30	25 38	26		
					Consistency tree layer	0.6	0.7	0.6	0.7	0.6	0.5	0.5	0.7	0.6	0.5	0.5	0.7	0.6	0.5	0.5	0.6	0.6	0.6		
					Tree height (m)	14 18	18 20	18 20	16 17	24	18 20	18	16 18	18 20	18	24 22	12	21	26	21	28	19 24	12 23		
					Tree diameter (cm)	16 18	20 22	38 40	28 30	50	34 38	22 24	18	34	36 38	40 26	12 14	26 40	40	46	48	28 44	18 48		
					Herbaceous layer coverage (%)	50	60	60	55	40	50	60	50	50	50	60	60	40	40	40	50	50	50		
					Area (m^2)	800	800	600	800	800	800	800	800	600	400	400	800	800	800	800	800	800	800		
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
MPh	E	0	0	0	As. *Picea abies*	4	4	3	4	3	3	3	4	4	3	2	4	4	3	3	4	4	4	V	50.3
H	End	3.5	2	1.5	As. *Soldanella oreodoxa*	1	1	1	1	+	1	2	1	1	1	2	2	+	+	+	+	+	+	V	5.33
					Soldanello majori-Piceion, Piceion excelsae																				
H	Ec	3.5	2.5	2.5	*Luzula sylvatica*	2	3	2	.	+	+	+	+	+	+	1	1	2	2	+	1	+	1	V	7.3
H	Alp-E	3.5	2.5	2.5	*Homogyne alpina*	.	.	+	+	1	.	+	+	.	.	1	+	+	+	+	1	+	+	IV	1.11
H	Eua	4	2.5	1.5	*Calamagrostis villosa*	.	.	+	+	1	.	.	.	.	.	.	+	1	1	1	1	1	.	III	1.75
H	Carp-B	3	0	0	*Hieracium transsilvanicum*	.	+	+	.	.	.	.	+	.	.	.	.	+	+	+	+	+	.	III	0.22
H	Ec	4	2	4	*Gentiana asclepiadea*	.	.	.	+	.	.	.	.	.	.	.	+	+	+	+	+	+	.	II	0.19
G	Cp	3	2.5	4.5	*Gymnocarpium dryopteris*	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	+	+	II	0.13
H	End	4	2	3	*Leucanthemum waldsteinii*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	I	0.05
G	Cp	3.5	2	2	*Phegopteris connectilis*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	I	0.05
H	E	3.5	2.5	0	*Ranunculus platanifolius*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I	0.02
					Piceetalia excelsae																				
H	Cp	0	0	1	*Deschampsia flexuosa*	.	.	+	1	1	.	.	.	.	.	.	+	+	+	+	1	+	+	III	1.02
mPh	Arct-Alp	2.5	1.5	4	*Juniperus communis* subsp *alpina*	.	.	+	+	.	.	1	+	.	.	.	2	+	.	.	2	.	.	II	2.33
H	Cp	3.5	0	0	*Dryopteris dilatata*	+	.	+	+	+	.	.	.	.	.	.	+	.	.	.	+	+	.	II	0.47
Brchs	Cp				*Sphagnum girgensohnii*	.	.	.	.	.	.	2	+	.	.	.	.	.	.	.	.	.	.	I	1
H	Eua	2.5	3	2	*Calamagrostis arundinacea*	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	I	0.83
H	E	2.5	2.5	2	*Luzula luzuloides*	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	+	.	.	I	0.08
Ch	Cp-Bo	5	2.5	1	*Lycopodium annotinum*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	I	0.05
					Vaccinio-Piceetea																				
Ch	Cp	0	2	1	*Vaccinium myrtillus*	2	+	2	4	.	+	+	1	1	1	+	2	3	3	2	2	3	4	V	19
H(G)	Cp	4	3	3	*Oxalis acetosella*	.	+	1	+	.	1	.	.	+	.	+	1	+	+	+	1	1	+	IV	1.61
mPh	E	3	2.5	2	*Sorbus aucuparia*	+	+	.	+	.	+	+	+	.	.	+	.	+	.	+	+	+	.	IV	0.30

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
H	Cosm	4	2.5	0	*Athyrium filix-femina*	.	.	+	+	.	+	.	.	.	.	+	.	+	+	.	+	+	+	III	0.25
Brchs	Cosm				*Polytrichum juniperinum*	.	.	+	.	3	.	1	2	.	.	.	2	.	.	.	.	.	2	II	4.33
Ch	Cosm	3.5	2	2	*Huperzia selago*	+	.	.	.	.	.	.	.	.	+	.	.	+	+	.	1	+	.	II	0.41
H	End	3.5	2	2	*Campanula abietina*	.	.	+	.	.	.	.	.	.	.	.	+	+	+	.	+	+	.	II	0.16
H	Cp	3.5	2	1.5	*Blechnum spicant*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	.	II	0.11
Ch	Cp	3	2	1	*Vaccinium vitis-idaea*	.	.	+	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	II	0.11
nPh	Ec	3	2.5	3	*Rosa pendulina*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	II	0.11
G	Cp	4	2	2	*Streptopus amplexifolius*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	.	II	0.11
H	Alp-Carp-B	0	0	3	*Laserpitium krapfii*	.	.	.	+	+	.	.	.	.	.	.	+	+	.	.	.	.	.	II	0.11
Brchs	Cp-Bo				*Polytrichum strictum*	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	0.97
MPh	Alp-Ec	0	2	0	*Pinus mugo*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	.	.	I	0.30
mPh	Ec	3	2	3	*Lonicera nigra*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	I	0.08
mPh	Alp-Carp-B	4	2	2	*Salix silesiaca*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	I	0.08
MPh	Ec	4	3	0	*Abies alba*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	I	0.05
H	Arct-Alp	2.5	1	2	*Festuca supina*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	I	0.05
G	Cp-Bo	3	0	3	*Corallorrhiza trifida*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I	0.02
H(G)	Alp-E	3	2	0	*Gentiana punctata*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I	0.02
G(H)	Cp	3	2	2.5	*Moneses uniflora*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I	0.02
Ch	Cp	3	0	0	*Orthilia secunda*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I	0.02
Ch	Eua	2	2	2	*Veronica officinalis*	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I	0.02
					Querco-Fagetea																				
H	Ec	3	0	4	*Lamium galeobdolon*	+	+	.	.	.	.	.	.	.	.	+	+	+	+	.	+	+	.	III	0.22
G	Cp	3.5	4	0	*Anemone nemorosa*	+	+	.	.	.	+	+	+	.	.	.	.	.	.	.	+	+	.	II	0.47
H	Eua	3.5	3.5	3.5	*Polystichum aculeatum*	.	.	.	.	.	.	+	.	.	+	.	.	+	+	.	.	+	.	II	0.13
nPh	Eua	3.5	3	3	*Daphne mezereum*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I	0.02
MPh	E	3	3	0	*Fagus sylvatica*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	.	I	0.08
nPh	E	3	2.5	2	*Rubus hirtus*	.	.	.	.	.	+	+	.	.	.	+	.	.	.	.	.	.	.	I	0.08
H	Ec	3	2.5	4	*Veronica urticifolia*	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	.	I	0.08
H	Cp	4	3	0	*Dryopteris filix-mas*	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	I	0.05
H	E	3	3	3	*Hypericum montanum*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I	0.05
					Betulo-Adenostyletea																				
G	Ec	3.5	2	3	*Doronicum austriacum*	.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	+	+	.	II	0.16
G	Eua	3	2.5	2.5	*Polygonatum verticillatum*	.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	+	+	.	II	0.16

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
H	Alp-E	3.5	2	0	*Adenostyles alliariae* subsp. *kerneri*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	.	II	0.13
H	E	3.5	3	3	*Stellaria nemorum*	.	.	.	+	.	+	.	.	.	.	+	.	.	.	.	.	.	+	II	0.11
G	Eua	4	2.5	4	*Veratrum album*	.	.	.	.	.	+	.	+	.	.	+	.	.	.	.	+	.	.	II	0.11
H	Alp-Carp-B	3.5	1.5	4	*Aconitum degenii*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	I	0.05
H	Alp-E	3.5	2	0	*Rumex alpinus*	.	.	.	.	.		+	+	.	.	.	.	.	.	.	.	.	.	I	0.05
MPh	Alp-E	3.5	2.5	3	*Alnus viridis*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I	0.02
H	End	4	2.5	0	*Heracleum palmatum*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I	0.02
					Nardo-Callunetea																				
G	Alp-Carp-B	3	1	2	*Crocus heuffelianus*	+	+	.	.	.	2	2	2	1	.	.	.	.	.	.	+	.	.	II	3.27
H	Eua	4	3	3	*Hypericum maculatum*	.	.	+	+	.	.	.	.	.	.	.	+	+	+	.	+	+	.	II	0.19
H	E	0	0	1.5	*Nardus stricta*	+	.	.	.	.	1	1	1	+	.	.	1	.	.	.	+	.	.	II	1.19
H	Cp-Bo	3	0	0	*Festuca rubra*	2	+	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	I	3.08
H	Cp	3	2	2	*Luzula multiflora*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	I	0.05
					Epilobietea angustifolii																				
nPh	Cp	3	3	3	*Rubus idaeus*	+	+	+	+	.	+	+	.	.	.	+	+	+	+	+	+	.	.	IV	0.33
H	Eua	3.5	3	3	*Senecio nemorensis*	.	.	+	.	.	.	.	.	.	+	.	+	+	+	+	+	+	.	III	0.22
H	Cp	4	1.5	0	*Epilobium angustifolium*	.	.	.	+	.	1	1	.	.	.	+	+	.	.	.	.	.	.	II	0.63
mPh	Cp	3	2	3	*Sambucus racemosa*	+	+	.	.	.	+	.	.	.	.	+	.	+	+	.	.	.	.	II	0.16
					Variae syntaxa																				
H	Arct-Alp	3	1.5	4.5	*Polystichum lonchitis*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	+	II	0.13
H	Cp	3.5	2	3	*Dryopteris cristata*	.	.	+	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	II	0.11
Brchs	Cp				*Rhytidiadelphus triquetrus*	.	+	2	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	I	1.27
H	End	2	4	4.5	*Festuca rupicola* subsp. *saxatilis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	I	0.27
H	Cosm	3	0	0	*Rumex acetosa*	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	I	0.08
H	Eua	3.5	3	3	*Actaea spicata*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	I	0.05
H	Ec	4	2.5	4	*Aconitum vulparia*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	I	0.05
H	End	2.5	2.5	4.5	*Aconitum callibotryon*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.+	.	I	0.05
H	Cp	4	2	4	*Asplenium viride*	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I	0.02
H	Carp-B	4	2	4	*Trollius europaeus*	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I	0.02

Place and time of surveys: 1 – 2 Făgete Mountain (15.05.2021) 46°46′402″N. 22°39′599″E; 46°46′335″N. 22°39′602″E; 3 –Micău Mountain (22.08.2021) 46°41′535″N. 22°45′916″E; 4 – Management unit I Boceasa. Compartment 107C (Mountain peak below the Șutanu subalpine plain) (23.09.2021) 46°40′211″N. 22°42′424″E; 5 – Management unit I Boceasa. Compartment 105. Șutanu stream source (23.09.2021) 46°40′396″N. 22°43′180″E; 6 – Muncei peak (21.05.2022) 46°42′189″N. 22°39′628″E; 7 – 8 Poiana Drăgoteanului (21.05.2022) 46°43′007″N. 22°39′503″E; 46°43′999″N. 22°39′406″E; 9 –Muncei Peak (edge of Alpine plain) (27.05.2022) 46°41′371″N. 22°38′966″E; 10 – Gruiu Ursului (27.05.2022) 46°43′447″N. 22°38′682″E; 11 – Chenţu stream (peak and plateau) (15.06.2022) 46°44′025″N. 22°39′447″E; 12 – Vlădeasa Mountain (the upper third of the slope of the Zârna Valley in the area of origin) (11.09.2022) 46°46′547″N. 22°47′671″E; 13 – 14 Moceasa Mountain. Management unit I Boceasa. Compartment 130E. Compartment 104C (15.06.2022); 15 – Cetăţile and Moara Dracului waterfall. Management unit I Boceasa. Compartment 140A (20.06.2022); 16 – Upper basin of Zârna Valley. Management unit I Boceasa. Compartment 9D (20.06.2022); 17 – Upper basin of Crăciunului Valley - Nimăiasa Stream. Management unit I Boceasa. Compartment 76B (07.07.2022) 46°41′902″N. 22°46′060″E; 18 –Manului Stream. Management unit I Boceasa. Compartment 84E (07.07.2022).

DISSCUSION

In his book published in the prestigious Publishing House of the Romanian Academy, Resmeriță (1970) [41] describes three associations includes in the forest ecosystems of the spruce forest of the Vlădeasa Mountains as follows:

- *Piceetum montanum* association – subas. *austrocarpaticum* Borza 1959 named today *Hieracio transsilvanici-Piceetum* Pawlowski et Br.-Bl. 1939 (Syn.: *Piceetum carpaticum* Soó 1930 (Art.34); *Piceetum montanum* sensu auct roman (Art.34, 36); *Luzulo sylvaticae-Piceetum* M.Wraber 1973 according to Chifu *et al*. (2014) [19], Sanda *et al*. (2008) [44]. The floristic composition of the association is explained by Table no. 56 [41] with 4 vertical columns: phytocenotic value, species, A+D (abundance+dominance), in the table the 43 species being ordered according to the criteria of belonging to *Gramineae* (3 species): *Deschampsia flexuosa*, *Agrostis tenuis*, *Poa nemoralis*; *Cyperaceae* and *Juncaceae* (2 species): *Luzula luzuloides*, *Luzula sylvatica*; other species (38): *Picea abies*, *Homogyne alpina*, *Oxalis acetosella*, *Hieracium transsilvanicum*, *Soldanella montana*. It is specified in the legend that the species included in a single relief come from Vlădeasa Mountain, Făget, Răchițele, Răcad Valley, Drăgan Valley.
- Association *Piceetum subalpinum* – subas. *austrocarpaticum* Borza 1959. The floristic composition of the phytocoenosis is relate in Table no. 57 [41] structured according to the same criteria as Table no. 56 [41]: *Gramineae* (4 species): *Deschampsia flexuosa*, *Festuca rubra*, *Agrostis tenuis*, *Nardus stricta*; *Cyperaceae* and *Juncaceae* (2 species) *Luzula sylvatica*, *Luzula luzuloides*; other species (13): *Picea abies* A+D=4-5, K=V, *Homogyne alpina* A+D=+-1, K=V, *Soldanella montana* A+D=+-1, K=V, *Oxalis acetosella* A+D=+-1, K=V, *Laserpitium krapfii* A+D==-+, K=IV. The species of the relief come from Vlădeasa, Vârfuraș, Micău Mountains, altitude 1400-1530 m. This relevé, according to the structure and floristic composition of the phytocoenosis, could currently be included in the association *Soldanello oreodoxae-Piceetum* Coldea et Wagner 1998 corr. Coldea 2015.
- Association *Piceeto-Juniperetum vacciniosum* n. ass. currently called *Piceeto-Juniperetum sibiricae* Br.-Bl. 1930 (Syn.: *Piceeto-Juniperetum vaccinietosum* Resmeriță 1970 (Art.2b) [19] respectively *Piceeto-Juniperetum sibiricae* Br.-Bl. 1930 [44]. The floristic structure and composition in Table no. 58 [41] follow same criteria as in previous tables: *Gramineae* (5 species): *Deschampsia flexuosa* K=V, *Festuca rubra* K=V, *Agrostis tenuis* K=III, *Nardus stricta* K=I, *Deschampsia caespitosa* K=I; *Cyperaceae* and *Juncaceae* (2 species*): Luzula luzuloides* K=III, *Luzula sylvatica*, K=II; other species (17): *Picea abies* A+D=1-3, K=V*, Vaccinium myrtillus* A+D=+-2, K=V, *Vaccinium vitis-idaea* A+D=+-1, K=V, *Homogyne alpina* A+D=+-2 K=V, J*uniperus sibirica* A+D=3-5, K=V, *Soldanella montana* A+D=+-1, K=V, *Crocus heuffelianus* A+D=+, K=V, *Campanula abietina* A+D=+, K=IV, *Antennaria dioica* A+D=+, K=II. The species of the relief come from the Vlădeasa, Micău and Vârfuraș Mountains. According to the structure and floristic composition of the phytocoenosis this survey could also be included in the *Soldanello oreodoxae-Piceetum* Coldea ei Wagner 1998 corr. Coldea 2015.

According to the research carried out on the vegetation of the forest ecosystems built by *Picea abies* in the Vlădeasa Mountains and adjacent in the Apuseni Mts., it follows that:

- Resmeriță (1970) [41] in his book „Flora, vegetation and the productive potential on the Vlădeasa Massif" describes 3 associations that we have previously listed, and in the floristic composition on the phytocoenosis of forest ecosystems built by *Picea abies* cites both in the text and in the association table the presence of *Soldanella major* (*S. montana*) in all 3 communities.
- Ciocârlan (2009) [11] includes species *S. hungarica* Simonk., *S. marmarossiensis* Kldst., *S. oreodoxa* L.B. Zhang as part and belongs to a single species called *Soldanella major* (Neilr.) Vierh. which colonizes the entire Carpathian chain and does not trust the molecular and area determinations of L.B Zhang (2002, 2004) [58-59]. The late professor and botanist at USAMV Bucharest believed that further research on the variability of the *Soldanella* genus was needed.
- Sârbu *et al*. (2013) [49] specifies that the following species grow in Romanian Carpathians (*S. pusilla* Baumg. subsp. *pusilla* in the Southern Carpathians, End. Carpathian Balkan, *S. rugosa* L.B. Zhang in the Rodnei and Călimani Mountains, End. Eastern Carpathians, *S. angusta* L.B. Zhang in the Giurgeu Mountains, Nemira, Harghita, End. Eastern Carpathians, Romania and Ukraine, *S. marmarossiensis* Klášt Eastern Carpathians, Ukraine, Tatra Mountains, *S. hungarica* Simonk. End. The Southern Carpathians, *S. oreodoxa* L.B Zhang, Muntele Băișoarei in „Scărita-Belioara" reservation, Vlădeasa Mountains, End. Apuseni Mts., *S. major* (Neilr.) Vierha. (*S. hungarica* Simonk. subsp. *major* (Neilr.) Pawlowska) Eastern Alps, Southern Carpathians.
- Chifu *et al*. (2014) [19] in his book „Phytocoenologic diversity of Romania vegetation. Tome III. Forest and scrub vegetation", describes the association *Soldanello majoris-Piceetum* Coldea et Wagner 1998 synthetic table 35, column 3 as being present in the Eastern and Occidental Carpathians having characteristic species on *Picea abies* and *Soldanella major*.
- Togor, 2016 [53] identified in Bihor Mountains floristic in the territory *S. oreodoxa*, reason why we fully subscribe to the presence of this species in the Occidental Carpathians and as such we resorted to the changes regarding the acceptance of this

phytotaxon in the association table and in the floristic composition of spruce phytocoenosis of upper limit *Soldanello oreodoxae - Piceetum* Coldea et Wagner 1998 corr. Coldea 2015.

- Valachovič *et al*. (2019) [55] is based on a lot of published data in Austria, Czech Republic, Slovakia, Poland, Ukraine, Romania revised according to the information gathered from a total of 4752 relevés provided by the European Vegetation Archive (EVA) according to Chytrý *et al*. (2016) [20] from which it follows that the only taxon *Soldanella oreodoxa* grows among all 10 species of the *Soldanella* genus in the Occidental Carpathians.

The authors of this article are of the opinion that the determinations of *Soldanella* taxa based on molecular analysis should not be considered exclusive, but on the contrary, new research on morphological characters on vegetative organs is necessary (root, stem, leaf, flower) and reproductive (gynoecium, regarding the placentation of the ovules and the position of the ovary, the number of carpels, the cycle arrangement of stamens in androecium) as well as the conformation of the fruit. Based on the molecular research done by Zhang *et al.* (2001, 2002, 2004) [57-59] we agree and have resorted in this article to the substitution of *Soldanella montana* species with *Soldanella oreodoxa* species.

The ecological analysis (Table 4) of the species included in the *Soldanello oreodoxae-Piceetum* association from the point of view of live forms highlights the dominance in very similar percentages of hemicryptophytes (60.7% Vlădeasa Mountains [6], 56.9% Apuseni Mountains, 50.82% Bihor Mountains [53]) which demonstrate favorable conditions for the development of phytocoenosis in similar habitats. Chamephytes resistant to snow and strong winds colonize high peaks and cliffs in percentages of 9.8% Vlădeasa Mountains [6], 8.2% Bihor Mountains [53] and 7.6% Apuseni Mountains.

The comparative study of the phytogeographic elements (Table 5) for the association's phytocenoses shows the dominance of circumpolar species in percentages of 31.7% Apuseni Mountains, 31.6% Vlădeasa Mountains [6], 22.95% Bihor Mountains [53], followed by alpine-carpatho-balkan together with balkan ones in percentages of 13.7% Vlădeasa Mountains [6], 10.1% Apuseni and 1.64% Bihor Mountains [53]. Endemic species appeared in the lowest percentages, 6.3% Apuseni Mountains, 3.28% Bihor Mountains [53], 1.9% Vlădeasa Mountains [6].

The analysis of the ecological indices (Table 6) characteristic of the habitat in relation to soil moisture highlights the dominance of mezo-hygrophilous species 62.3% Bihor Mountains [53], 60.7% Vlădeasa Mountains [6], 60% Apuseni Mountains, which means a close similarity regarding soil moisture.

Table 4. The comparative spectrum of bioforms for the phytocoenoses of the *Soldanello oreodoxae-Piceetum* association from the Vlădeasa Mountains [6], Bihor Mountains [53], Apuseni Mountains

Locality	H	G	Ch	Ph	T	Brchs
Vlădeasa Mountains [6]	60.7	11.8	9.8	17.7	-	-
Bihor Mountains [53]	50.82	21.31	8.2	16.4	3.27	-
Apuseni Mountains	56.9	12.6	7.6	17.7	-	5.1

Table 5. The comparative spectrum of floristic elements for the phytocoenoses of the *Soldanello oreodoxae-Piceetum* association from the Vlădeasa Mountains [6], Bihor Mountains [53], Apuseni Mountains

Locality	Cp	Alp-Carp-B	Carp-B	End	Arct-Alp	Alp-E	Alp-Ec	Eua	E	Ec	Cosm	MP
Vlădeasa Mountains [6]	31.6	5.9	7.8	1.9	-	-	-	15.8	13.9	19.6	3.9	-
Bihor Mountains [53]	22.95	-	1.64	3.28	4.92	-	-	24.59	14.75	21.31	6.56	-
Apuseni Mountains	31.7	7.6	2.5	6.3	3.8	6.6	1.3	12.6	11.4	11.4	5.1	-

Table 6. The comparative spectrum of the ecological indices (M=Soil Moisture, T=air temperature, R=chemical reaction of the soil) for the phytocoenoses of the *Soldanello oreodoxae-Piceetum* association

Locality	Ecological indices	The value of the ecological indices and the number of species/%									
		1	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**0**
Vlădeasa Mountains [6]	U nr sp.	-	-	-	4	15	16	11	-	-	5
	%	**-**	**-**	**-**	**7.8**	**29.4**	**31.3**	**21.5**	**-**	**-**	**9.8**
	T nr.sp	-	4	15	15	8	1	-	-	-	8
	%	**-**	**7.8**	**29.4**	**29.4**	**15.6**	**1.9**	**-**	**-**	**-**	**15.6**
	R nr.sp		7		-		12		9	-	9
	%		**13.7**		**-**		**23.5**		**17.6**	**-**	**17.6**
Bihor Mountains [53]	U nr.sp.	-	-	1	1	21	17	15	2	1	3
	%	**-**	**-**	**1.6**	**1.6**	**34.4**	**27.9**	**24.6**	**3.3**	**1.6**	**4.9**
	T nr.sp.	-	1	16	15	16	2	1	-	-	10
	%	**-**	**1.6**	**26.2**	**24.6**	**26.2**	**3.3**	**1.6**	**-**	**-**	**16.4**
	R nr.sp.		6		13		17		10	-	14
	%		**9.8**		**18.8**		**27.9**		**16.4**	**-**	**22.9**
Apuseni Mountains	U nr.sp.	-	-	2	5	24	21	16	-	1	6
	%	**-**	**-**	**2.7**	**6.7**	**32**	**28**	**21.3**	**-**	**1.3**	**8**
	T nr.sp.	2	4	25	18	11	1	2	-	-	12
	%	2.7	**5.3**	**33.3**	**24**	**14.7**	**1.3**	**2.7**	**-**	**-**	**16**
	R nr.sp.		9		17		18		13	-	18
	%		**12**		**22.7**		**24**		**17.3**	**-**	**24**

Compared to air temperatures, the habitats provide favorable climatic conditions for microtherm species in percentages of 58.8% Vlădeasa Mountains [6], 57.3% Apuseni Mountains, 50.8% Bihor Mountains [53].

The chemical reaction of the soil and the rock substrate favors the development of acid-neutrophil species, 27.8% Bihor Mountains [53], 24% Apuseni Mountains, 23.5% Vlădeasa Mountains [6], succeeded by euriionic ones 24% Apuseni Mountains.

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