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Vegetation of Subalpine, Heliophilous, Tall Grass Meadows with High Conservation Values Built by the Communities *Hyperico grisebachii-Calamagrostietum villosae*, *anemonetosum narcissifloliae* subas. nova, Syntaxonomy, Ecology, Protection and Management in the South-East European Carpathians, Romania

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ABSTRACT

This paper is a syntaxonomic, phytosociological, ecological, ecoprotective study of tall, subalpine, heliophilous, mesophilous, microthermic grasses, included in the vegetation class *Betulo-Adenostyletea* (Syn: *Mulgedio-Aconietea*) from the Western Carpathians (Apuseni Mountains), Bihor-Vlădeasa Mountains, Romania and the reviews of the results we obtained in comparison with recent scientific data obtained by some European researchers from the Eastern Carpathians of Ukraine and the Western Carpathians of Slovakia. The study carried out with new scientific data on the floristic, coenotaxonomic composition of the *Hyperico grisebachii-Calamagrostietum villosae* community, concretized by listing the species found in the territory in a synthetic association table, identifying the characteristic, differential and constant taxa of the plant alliances (*Calamagrostion villosae*), orders (*Calamagrostietalia villosae*) and classes (*Betulo-Adenostyletea*). In the study's first step, we put forward a nomenclature reviewing of the original syntaxa, of those with synonymies that define the plant associations, alliances, orders and classes, of the grassland communities containing high concentrations of biodiversity within the surveyed region, in accordance with the definitions, principles, rules and recommendations of the phytosociological nomenclature codes of different authors. Another important objective of the work was the ecological review of the component species of the meadows by criteria of belonging to the type of bioform, phytogeographic element as well as the relationships of the phytocoenosis species with ecological factors i.e. soil moisture, air temperature and chemical reaction of the soil amid global climate changes.

Keywords: tall grass, high conservation values, syntaxonomy, ecology.

INTRODUCTION

The surveyed territory with an area of 280 km^2 belongs to the Carpathian Mountains chain in Western Romania, the following mountain ranges: Buteasa Mountain (1,732 m), Briței Mountain (1,710 m), Cirque Glacier - Drăganului Valley origin (1,631 m), Cârligate Mountain (1,684 m), Bohodei Mountain (1,628 m) which are all subalpine sites where the community of tall grass of *Hyperico grisebachii-Calamagrostietum villosae* occupies a total area of about 1,000 ha compared to an area of 2,000 ha colonized by the same plant community in the Rodna Mountains (Coldea, 1990).

The purpose of our work consists in carrying out a syntaxonomic, phytosociological, ecological, ecoprotective study of the high conservation value grasslands in the *Hyperico grisebachii-Calamagrostietum villosae* community, ***Betulo-Adenostyletea*** class, built by *Calamagrostis villosa*, *Hypericum richeri* subsp. *grisebachii*, *Anemone narcissifolia*, *Allium victorialis* on debris and rocks within rare, endangered natural habitats of community interest.

To achieve the goal, we set ourselves the following objectives:

❖ Carrying out the floristic inventory resulting in highlighting the species that

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make up the living soil cover of subalpine grasslands;

❖ Syntaxonomic reviewing of the classifications of grassland communities studied and published previously, corrections and improvements adopted in the work, especially for high conservation value grasslands in the surveyed territory, making it possible to compare them with the syntaxonomic nomenclature data of grassland vegetation from other European countries;

❖ Describing the structure of the meadow phytocoenosis according to the vertical distribution of species in vegetation layers or living soil covers;

❖ Highlighting the coenotic behaviour of species by their affinity towards hierarchically higher syntaxa, plant alliance, order and class;

❖ Performing ecological characterization of the vegetation of subalpine tall grass meadows through the lens of the species belonging to the type of life form, phytogeographic element and the categories of ecological indices: soil moisture, air temperature, chemical reaction of the soil, and genetic karyotype;

❖ Studying the current state of the meadows, threats, protection status and management.

Research history and current state of knowledge

On the territory of Romania, the *Hyperico grisebachii-Calamagrostietum villosae* grassland community is little known, although it was described in the Retezat Mountains (Coldea, 1993), the Rodna Mountains (Coldea, 1990), the Călimani Mountains (Horeanu and Vițelariu, 1991).

In Europe, knowledge about subalpine communities of tall grasses belonging to the class ***Mulgedio-Aconietea*** (Syn: ***Betulo-Adenostyletea***), with a brief description of the association *Hyperico alpigeni-Calamagrostietum villosae*, spread over medium-sized areas (100-200 m^2) up to 400 m^2, in the Ukrainian Carpathians, the subalpine belt and the lower part of the alpine belt Chornohora, Chyvchyny, Western Gorgany, Hryniava Mountain and Marmarosh Mountain comes to us from the works of Malynovsky and Kricsfalusy (2000, 2002), Solomakha (2008), Iakushenko et al. (2012), Kricsfalusy (2013), and Kyyak et al. (2021).

Research conducted in the Western Carpathians of Europe-Slovakia by Kliment et al. (2004), Kliment and Valachovič (2007), and Šibícová et al. (2008, 2010) provided us with scientific data on subalpine meadows of tall grasses with a floristic structure of the phytocoenoses of the *Hyperico alpigeni-Calamagrostietum villosae* association, much different from that of the phytocoenoses of the association described by us in the South-Eastern European Carpathians of Romania and from that of the phytocoenoses of the meadows described in the Eastern Carpathians by Ukrainian authors.

Maps taken from the website www.parcapuseni.ro, last accessed on 16.04.2025.
Source: https://www.parcapuseni.ro/index.php?option=com_content&view=article&id=3&Itemid=127.

Figure 1. Location of the Apuseni Mountains Natural Park

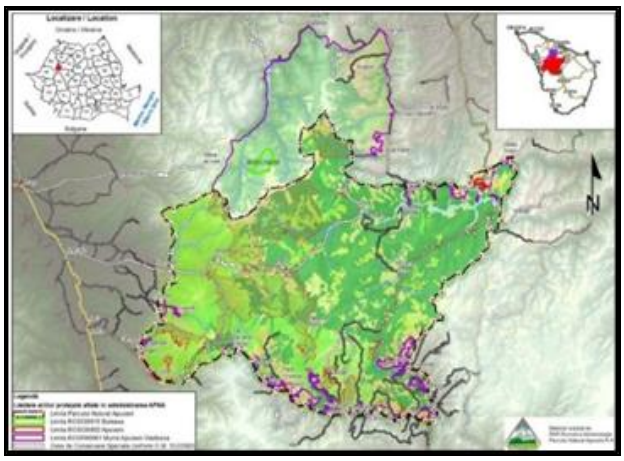


Figure 2. Borders of the Apuseni Mountains Natural Park

MATERIAL AND METHODS

The research was carried out between 2019-2024 in the Western Carpathians (Apuseni Mountains), Romania, Boceasa (Buteasa) Mountain Botanical Reserve (1,732 m), Briței Mountain (1,710 m), Cirque Glacier - Drăganului Valley origin (1,631 m), Cârligate Mountain (1,671 m), Bohodei Mountain (1628 m), in 15 phytosociological surveys (samples) (Figure 1 and Figure 2) on an average area of 100-200 m^2, and up to 400 m^2 in some sites, characterized by a temperate continental climate, with an annual average temperature of +3.5°C, ranging from -4.02°C (in the winter), to +7°C (in the spring), and +15.5°C (in the summer), with an annual average precipitation of 1,836.6 mm, according to data meteorological data taken and processed over a period of 10 years (2014-2023) from the Stâna de Vale Meteorological Station, Bihor County (sources: www.meteomanz.com).

When studying the structure of tall, heliophilous, subalpine grass meadows, we applied the phytosociological research methods of the Central European school developed by Braun-Blanquet (1964) adapted by Borza and Boșcaiu (1965) to the peculiarities of the Romanian vegetation.

In the study of the grassland cover, we adopted the "vegetable association" as basic syntaxonomic unit the in the context of the definition given by Géhu and Rivas-Martinez (1981).

In carrying out the surveys (phytosociological surveys) we followed the vertical stratification and the estimation of the grass density, and the degree of soil coverage using the abundance-dominance indices according to the Braun-Blanquet and Pavillard system (1928), corroborated with the indices of the constancy classes (K=I-V) which show us the degree of fidelity (general presence) of the species with respect to the environment of the phytocoenosis population in the association.

When classifying the species of meadow phytocoenoses in the association and in the hierarchically higher plant syntaxa, alliance, order, and class, we reviewed the ecological-floristic systems of the European authors Tüxen (1955), Braun-Blanquet (1964), Soó (1964-1980), Oberdorfer (1992), Pott (1995), Borhidi (1996), Rodwell et al. (2002), Iakushenko et al. (2012), Kricsfalusy (2013), Kliment et al. (2010, 2016), Mucina et al. (2016), Kyyak et al. (2021) and of the Romanian authors Borza and Boșcaiu (1965), Sanda et al. (2008), Chifu et al. (2014).

To classify tall grass species by bioform categories, we reviewed the system developed by Braun-Blanquet (1964), the works of the authors Ellenberg et al. (1992), Sanda et al. (2003), Burescu and Toma (2005), Ciocârlan (2009).

We performed the classification of phytocoenosis species by categories of phytogeographic elements (geoelements) according to the works developed by Meusel and Jäger (1992), Sanda et al. (2003).

We carried out the classification by categories of ecological indices, soil moisture, air temperature, and chemical reaction of the soil according to Sanda et al. (2003) and the data regarding the chromosomal karyotype of plant species was provided to us from the works of Ciocârlan (2009) and Moore (2009).

RESULTS AND DISCUSSION

Syntaxonomie and nomenclature

In the study of the high-mountain plant community, part of flora of Slovakia, Kliment and Valachovič (2007) argue that the problems of syntax and nomenclature have not been resolved, but only further cases of syntax and nomenclature have been discovered (Kliment et al., 2010).

With regard to the syntax and nomenclature of the meadows community of Eastern Carpathians (Ukrainian Carpathians) Kricsfalusy (2013) argues that their delimitation and classification as higher syntaxa are ambiguous because they were based on poorly documented surveys (sample areas). In this context, the Ukrainian author

proposes a syntaxonomic revision of the mountain meadow communities within the region, with adjustments and improvements including the classifications of the works previously published by Malynovski and Kricsfalusy (2000, 2002).

Central European researchers Kočí (2001, 2007), Dúbravcová et al. (2005), Šibíková et al. (2009), Michl et al. (2010), also advocate in their works for a new classification, a new syntaxonomic revision of the vegetation of the Western Carpathians.

In the study we conducted, the classification we used was carried out in accordance with a syntaxonomic scheme adopted by romanian researchers specialised in this domain and by the european specialists cited in this paper, considering the specific living conditions of the habitats within the surveyed region, the plants ecology, the high conservation values, the red lists, the structure of meadows phytocoenosis and last but not least, the current state of the plant community, the evolution trend in the syndinamics of the plant association.

Description of the structure of the phytocoenosis of subalpine meadows

Phytocoenosis of subalpine meadows has a complex, multi-layered structure in which populations of species cohabit, being distributed by several layers called synusie or ecological niches in which they bring together the same type of bioforms.

The first layer of the meadow living soil cover overlaps with the synusie of species i.e. tall grasses (50-110 cm) with poaceae such as *Calamagrostis villosa*, *Calamagrostis arundinacea*, *Deschampsia flexuosa*, *Poa chaixii*, *Poa alpina*, *Festuca rubra* subsp. *nigriscens*, with weeds *Achillea distans* subsp. *stricta*, *Adenostyles alliariae* subsp. *kerneri*, *Anemone narcissifolia*, *Epilobium angustifolium*, *Veratrum album*, *Cirsium erisithales*.

The second layer, 20-50 cm high, hosts the species *Hypericum richeri* subsp. *grisebachii* (*Hypericum alpigenum*), *Allium victorialis*, *Arnica montana*, *Festuca picta*, *Luzula luzuloides*, *Luzula multiflora*, *Rumex alpestris*, *Silene vulgaris* subsp. *prostrata*, *Senecio subalpinus*, *Lilium jankae*, *Lilium martagon*, *Phyteuma vagneri*, *Phyteuma tetramerum*, *Aconitum vulparia*, *Campanula serrata*, *Bupleurum diversifolium*, the third layer consists of tall plants (10-20 cm) i.e. *Thymus comosus*, *Thymus bihoriensis*, *Alchemilla vulgaris*, *Aposeris foetida*, *Viola declinata*, *Hieracium alpinum*, *Antennaria dioica*, *Thesium alpinum*, *Geum montanum*, *Homogyne alpina*, *Potentilla ternata* (Syn: *Potentilla aurea* subsp. *chrysocraspeda*). The fourth layer, attached to the soil, consists of the lichens-endophytes *Cetraria islandica*, *Cladonia rangiferina* and the mosses-bryophytes *Rhytidiadelphus squarrosus*, *Hylocomium splendens*, *Polytrichum juniperinum*.

Coenotic behaviour of species, delimitation and classification in higher syntaxa

The floristic inventory of the *Hyperico grisebachii-Calamagrostietum villosae* community we studied in the South-East European Carpathians, Bihor-Vlădeasa mountains, totals 103 species, being the subalpine meadow association in Romania that contains the largest number of vascular plants, the highest biodiversity of vegetation in the ***Betulo-Adenostyletea*** class (Syn: ***Mulgedio-Aconietea***) compared to a number of 111 species found by Iakuskenko et al. (2012) in a syntaxonomic reviewing study and against a total of 181 vascular plant species reported by Kricsfalusy (2013) in a work of syntaxonomy and evaluation of the vegetation of high altitude tall grass meadows from the Eastern Carpathians (the East European Carpathians) in Ukraine.

The edifying species that dominate and instils the physiognomy of the association are *Calamagrostis villosa* with a coverage of 37.83% average abundance-dominance (ADm), maximum constancy (K=V).

Hypericum richeri subsp. *grisebachii*, average abundance-dominance of 11.66%, maximum constancy (K=V), found in a codominance relationship.

Figure 3. Hyperico grisebachii-Calamagrostietum villosae association - *anemonetosum narcissifoliae* subas. nova (Bohodei Mountain, 17.07.2023, original)

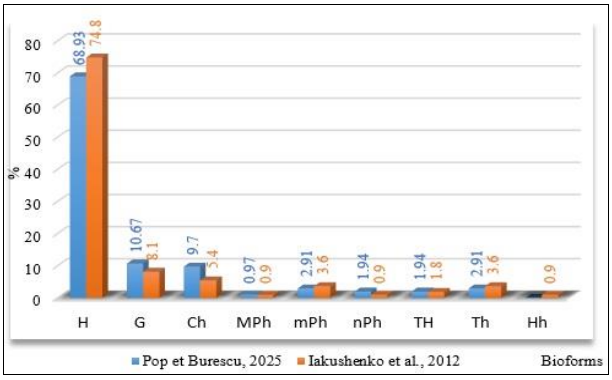
Along with the edifying species that build and define the phytocoenosis in the floristic composition of the association, there are also 10 species characteristic or specific to the ***Calamagrostion villosae***: *Festuca picta*, *Campanula abietina*, *Dianthus barbatus* subsp. *compactus*, *Phyteuma vagneri*, *Centaurea kotschyana*, *Gentiana lutea*, *Geum montanum*, *Homogyne alpina*, *Potentilla ternata*, *Festuca porcii*, seven characteristic species of the ***Calamagrostion arundinaceae*** alliance: *Calamagrostis arundinacea*, *Anemone narcissifolia*, *Allium victorialis*, *Silene vulgaris* subsp. *prostrata*, *Knautia dipsacifolia*, *Poa alpina*, *Agrostis capillaris*, eight species characteristic or specific to the order ***Calamagrostietalia villosae***: *Luzula luzuloides*, *Rumex alpinus*, *Digitalis grandiflora*, *Poa chaixii*, *Deschampsia flexuosa*, *Lilium jankae*, *Epilobium angustifolium*, *Phleum alpinum*, eight diagnostic (characteristic) taxa of the ***Adenostylion alliariae*** alliance: *Achillea distans* subsp. *stricta*, *Senecio ovatus*, *Adenostyles alliariae* subsp. *kerneri*, *Swertia punctata*, *Aconitum vulparia*, *Trollius europaeus*, *Thalictrum aquilegiifolium*, *Rubus idaeus*, nine diagnostic (characteristic) taxa of the order ***Adenostyletalia alliariae***: *Veratrum album*, *Gentiana asclepiadea*, *Rumex alpestris*, *Senecio subalpinus*, *Aconitum variegatum* subsp. *paniculatum*, *Doronicum austriacum*, *Phegopteris connectilis*, *Coeloglossum viride*, *Alnus viridis*, and nine diagnostic taxa of the class ***Betulo-Adenostyletea*** (Syn: ***Mulgedio-Aconietea***): *Arnica montana*, *Lilium martagon*, *Rosa pendulina*, *Athyrium distentifolium*, *Chaerophyllum hirsutum*, *Polygonatum verticillatum*, *Ranunculus platanifolius*, *Valeriana sambucifolia*, *Salix silesiaca*.

In this association, in addition to the characteristic taxa *Hypericum grisebachii* and *Calamagrostis villosa*, a nucleus of six different taxa: *Anemone narcissifolia*, *Calamagrostis arundinacea*, *Allium victorialis*, *Silene vulgaris*, *Knautia dipsacifolia*, *Poa alpina* forms a compact community that we included in the subassociation *anemonetosum narcissifoliae*. Holotypus hoc loco survey nr. 13 (Figure 3).

In the framework of association phytocoenoses, the explosive growth of *Allium victorialis* (victory onion or alpine leek) is specifically different from facies rank, facies nova. Holotype survey no. 12.

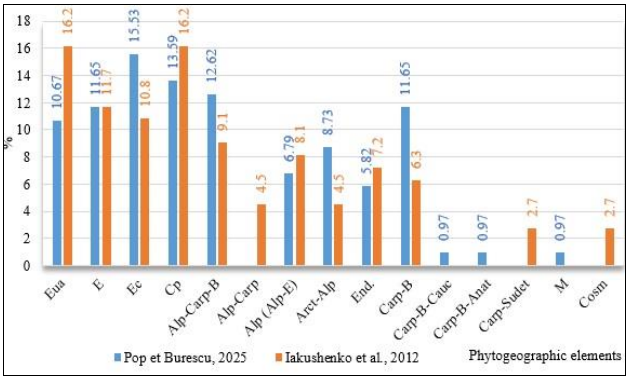
Analysis of bioforms (life form's) categories

The analysis of life forms (Figure 4) highlights results with parameters close to those obtained by us in the Western Carpathians of Romania: hemicryptophytes (68.93%), geophytes (10.67%), chamaephytes (9.7%), phanerophytes (5.72%), therophytes (4.85%), compared to those obtained in the Ukrainian Carpathians: hemicryptophytes (74.8%), geophytes (8.1%), chamaephytes (5.4%), phanerophytes (5.4%), therophytes (5.4%) obtained by Iakushenko et al. (2012).



Legend: H (Hemicryptophytes); G (Geophytes); Ch (Chamaephytes); MPh (Megaphanerophytes); mPh (Mesophanerophytes); nPh (Nanophanerophytes); TH (Biannual Therophytes); Th (Annual Therophytes); Hh (Helahydatophytes).

Figure 4. Comparative life form's spectrum Pop and Burescu (2025) and Iakushenko et al. (2012)



Legend: Eua (Eurasian); E (European); Ec (Central-European); Cp (Circumpolar); Alp-Carp-B (Alpine Carpathian Balkan); Alp-Carp (Alpine-Carpathian); Alp (Alp-E) (Alpine (European Alpine); End. (Endemic); Carp-B (Carpathian Balkan); Carp-B-Cauc (Carpathian Balkan Caucasian); Carp-B-Anat (Carpathian Balkan Anatolian); Carp-Sudet (South Carpathian); M (Mediterranean); Cosm (Cosmopolitan).

Figure 5. Spectrum of phytogeographic elements compared Pop and Burescu (2025) and Iakushenko et al. (2012)

Analysis of the categories of phytogeographic elements (geoelements)

Distribution of phytogeographic elements in the territory according to the geographical area (Figure 5) highlights similar results between the grassland coenoses of the two geographical regions and some differences between the percentage values of the Eurasian (10.67% and 16.2%), Central European (15.53% and 10.8%), Alpine-Carpathian-Balkan (12.62% and 9.1%), Arctic-Alpine (8.73% and 4.5%), Carpathian-Balkan (11.65% and 6.3%), Carpathian endemics (5.82% and 7.2%) elements as well as the absence of Carpathian-Balkan-Caucasian, Carpathian Balkan-Anatolian species from the Ukrainian Carpathians and the lack of Carpatho-Sudetic species from the Western Carpathians of Romania. One explains the presence of differences by the different living conditions, determined by the topography of the stations (altitude, latitude, longitude), the geographical exposure of slope, the angle of the slope, the geomorphological structure of the substrate, the chemistry of the soil, the chemistry of the water in the groundwater, the ambient temperature, the zoo-anthropic influence offered to the development of tall, heliophilous herbaceous vascular plants by the habitats of the two geographical regions i.e. the Western Carpathians of Romania and the Eastern Carpathians of Ukraine.

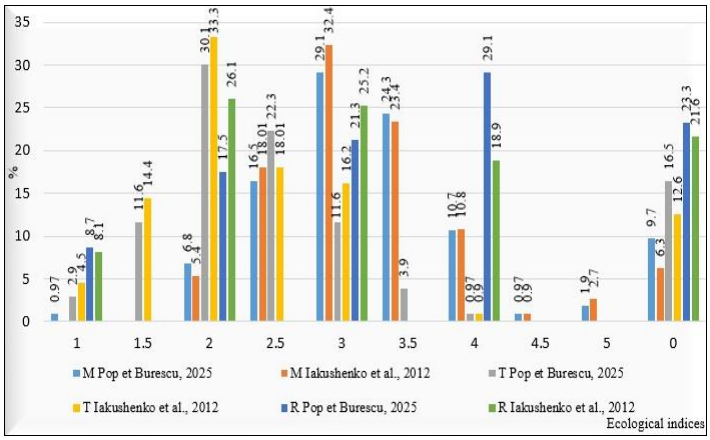
Ecological characterization of meadows by the behaviour of species towards ecological factors: soil moisture, temperature and chemical reaction of the soil.

Analysis of the ecological valences of the species, in response to the influence of environmental factors, soil moisture, air temperature, and chemical reaction of the soil (ecological indices) shows us a certain similarity but also some differences in the results parameters for the meadows from the two geographical regions of South-East European Carpathians, Romania and East European Carpathians, Ukraine.

Thus, with respect to soil moisture and air humidity (Figure 6), the plants of the phytocoenosis have a mesophilic (53.4%) to xeromesophilic (23.3%) and less mesohygrophilic (11.67%) character in the Bihor-Vlădeasa Mountains, the mountain massifs Boceasa (1732 m), Briței Peak (1710 m), Cârligate Peak (1671 m), Bohodei Peak (1628 m), Drăganului Valley origin (1631 m), sites we surveyed and a mesophilic (55.8%), xeromesophilic (23.41%) to mesohygrophilic (11.7%) character in the Ukrainian Districts Chornohora-Hoverla (2061 m), Marmarosh (1936 m), Gorgany (1836 m), surveyed by Iakuskenko et al. (2012), which highlights very close values regarding the humidity requirements for grassland species, phytocenoses from the two geographical regions of Romania and Ukraine (Figure 6).

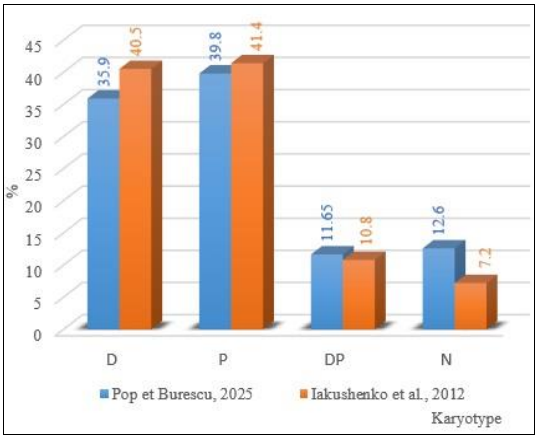
In relation to air temperature (Figure 6), the values of the ecological valences of the species association in the two geographical regions are close for some categories and different for others; thus the phytocenoses of the meadows in Romania have a microthermal (52.4%) to eurythermal (16.5%), cryophil-hechistothermal (14.5%) character and a microthermal (51.31%) to cryophil-hechistothermal (18.9%) to eurythermal (12.6%) nature in Ukraine. The existing differences are due to the size of the populations which are larger or poorer in terms of taxa, the higher altitudes in the Ukrainian Carpathians (1836-2061 m), the lower altitudes (1631-1732 m) in the Western Romanian Carpathians, the different composition of rocks and minerals, the structure and horizons of the soil.

With regard to the chemical reaction of the soil, the phytocoenoses of the *Hyperico grisebachii-Calamagrostieum villosae* association from the Bihor-Vlădeasa Mountains have a weak acid-neutrophilic character (29.1%) with an ecological optimum for a pH with values ranging between 6.5-7.0, a euryionic nature (23.3%) with a wide ecological amplitude of the pH in the acid-neutral-basic ranges, acid-neutrophilic character (21.3%) with an ecological optimum around a pH with values ranging between 5.8-6.5, and an acidophilic character (17.5%) with an ecological optimum around a pH with values ranging between 5.0-5.8; compared to the subalpine communities of heliophilous tall grasses from the Ukrainian Carpathians, which develop on base-poor skeletal soils, on siliceous rocks with species characteristics falling within the acidophilic (26.1%), acido-neutrophilic (25.2%), euryionic (21.6%) and weakly acido-neutrophilic (18.9%) domains (Figure 6).



Legend: M (Soil Moisture): M=1-1.5 (Xerophilic); M=2-2.5 (Xero-mesophilic); M=3-3.5 (Mesophilic); M=4-4.5 (Meso-hygrophilic); M=5 (Hygrophilic); M=0 (Eurihydric); T (Air Temperature): T=1-1.5 (Cryophilic); T=2-2.5 (Microthermal); T=3-3.5 (Micro-mesothermal); T=0 (Eurythermal); R (Chemical Reaction of the Soil): R=1 (Strong acidophilic); R=2 (Acidophilic); R=3 (Acid-neutrophilic); R=4 (Weak acid-neutrophilic); R=0 (Euriionic).

Figure 6. Comparative spectrum of ecological indices Pop and Burescu (2025) and Iakushenko et al. (2012)



Legend: Karyotype (2n): D (Diploid); P (Polyploid); DP (Diplopolyploid); N (Unknown Karyoptype).

Figure 7. Comparative chromosomal karyotype spectrum Pop and Burescu (2025) and Iakushenko et al. (2012)

Regarding the chromosomal karyotype (2n), a similarity is observed in which polyploid species predominate in both geographical regions (Western Carpathians of Romania and Eastern Carpathians of Ukraine) with a share of 39.8% in Romania and 41.4% in Ukraine, accompanied by diploid ones (35.9% Romania and 40.5% Ukraine) which ensures the unhindered circulation of genes within the population during panmixia (Figure 7).

Current state of the grasslands, threats, protection status and management

In the 18th, 19th and early 20th centuries, the subalpine tall grass communities in the

surveyed territory belonged mainly to the primary grassland vegetation with a rich floristic composition, mainly formed by montane, subalpine, arctic-alpine species included in the classes ***Betulo-Adenostyletea*** (Syn: ***Mulgedio-Aconietea***) and ***Juncetea trifidi***.

Currently, these have been reduced in places in favour of lands colonized by secondary grassland vegetation from the classes ***Nardo-Callunetea*** (Syn: ***Calluno-Ulicetea***), ***Molinio-Arrhenatheretea*** (Syn: ***Molinio-Juncetea***) and shrub vegetation from the orders ***Vaccinio-Juniperetalia*** and ***Junipero-Pinetalia mugi***.

Among the possible threats to grasslands, we recall the factors with negative potential (risk factors) such as: changes in the relief infrastructure (access roads, rural constructions), changes in the use of traditional grazing, excessive grazing, abandonment of grazing, afforestation with woody shrub species, regional climate changes going in parallel with the global ones.

Risk factors could trigger some major dynamic changes in the floristic composition of the phytocoenosis (Kyyak et al., 2021): disappearance of rare, endemic species, their substitution with ruderal ones, the reduction of the area populated by the *Hyperico grisebachii-Calamagrostietum villosae* community.

Climate change can largely determine the biodiversity of high, subalpine grass meadows, by adding an increasing pressure and competition within the phytocoenosis and habitat, between cold-loving species (microthermes, hechistothermes) and the heat-loving species (moderately thermophilic) and acidity-dryness-loving species (xeromesophiles) resulting in the restructuring of the floristic composition of the meadows in favour of the species best adapted to the living conditions.

From an economic perspective, meadows with *Calamagrostis villosa*, *Calamagrostis arundinacea*, *Hypericum grisebachii*, *Festuca picta*, *Festuca rubra*, *Festuca ovina* subsp. *supina*, *Anthoxanthum odoratum*, *Poa chaixii*, *Thymus comosus*, *Viola declinata*, *Anemone narcissifolia*, *Achillea distans* subsp. *stricta*, *Laserpitium krapfii* var. *alpinum*, are more productive (14,000 kg/ha) in terms of green phytomass consisting mainly of weeds (of lower quality) and less of good and very good forage species, from the *Poaceae* and *Fabaceae* families.

Protection status

Out of the total of 103 vascular cormophyte species found in the subalpine meadows of the Bihor-Vlădeasa Mountains, 30 species (i.e. 29.17%) were evaluated as representing high conservation values protected in special conservation areas. Of the total of 30 vascular plant species, eight species are under international protection, of which one species is on the IUCN Red List of Threatened Species (2011), four species are on the European Red List (Bilz et al., 2011), two species are included in the Bern Convention (1979) and two species are included in the Habitats Directive of the European Union (European Commission, 2007). A total of 22 species are in the Red Lists developed by Romanian authors and the Red Book of Plants of Romania.

According to the results we obtained in the surveyed territory, the biodiversity of the meadows of the *Hyperico grisebachii-Calamagrostiem villosae* community is the largest among all the meadows of the ***Betulo-Adenostyletea*** class (Syn: ***Mulgedio-Aconietea***) a fact also demonstrated by the research conducted at European level in the Ukrainian Carpathians by Kricsfalusy (2013), who found a total of 181 vascular plant species, of which 14 species (7.7%) are threatened, vulnerable, endangered taxa at global, European and national levels.

Research on the syntaxonomic status of subalpine communities of tall, heliophilous grasses carried out in the Ukrainian Districts, Eastern Carpathians by Iakuskenko et al. (2012), also highlights a rich floristic biodiversity estimated at 111 vascular plants, of which 18 species (16.21%) are threatened taxa at global, European and national levels.

Protection status of the meadows of the *Hyperico alpigeni-Calamagrostietum villosae* association is for protection and conservation in protected natural areas in Romania with

the codes ROSCI002 Apuseni Mountain and ROSCI0016 Boceasa Mountain for the species in the following categories: VU (Vulnerable), EN (Endangered), CR (Critically Endangered), NT (Near Threatened), LR (Lower Risk), R (Rare), END (Endemic), RG (Glacial Relict), MN (Monument of Nature) (Dihoru and Dihoru, 1994; Oltean et al., 1994; Oprea, 2005; Chifu et al., 2006; Sârbu et al., 2007; Dihoru and Negrean, 2009).

The plant association of these meadows is endemic to the South-East European Carpathians and the Eastern Carpathians (Eastern Ukrainian Carpathians).

Most of the mountain and subalpine grasslands on the plateaus of the Apuseni Carpathians, the Bihor-Vlădeasa Mountains have been and are still subject to moderate grazing by traditional methods; this does not apply to those on the steep slopes on small areas, inaccessible to humans and animals, which have preserved their natural primary grassland structure unaltered.

However, it is necessary, even in the case of these natural structures, to harmonize sustainable management in the medium and long term, in accordance with global climate change, in order to preserve biodiversity, species with high conservation value through environmental policies that regulate the management of protected natural areas i.e. Boceasa Mountain, Briței Mountain and the Apuseni Mountains Natural Park.

CONCLUSIONS

The subalpine, tall heliophilous herb communities westudied in the Bihor-Vlădeasa Mountains, the Western Carpathians of Romania have a rich floristic composition estimated at 103 taxa whose nomenclature is in accordance with the scientific works of European phytosociologists, and with the principles, rules and recommendations of the phytosociological nomenclature codes.

Vegetation of the coenoses edified up by Alpine St. John's wort (*Hypericum richeri* subsp. *grisebachii*), hairy reed grass (*Calamagrostis villosa*) and anemone (*Anemone narcissifolia*) have a predominantly mesophilic (53.4%), microthermal (52.4%), weakly acid-neutrophilic (29.1%) to euryionic (23.3%) character, and partially moderately acidic (21.3%) nature.

Composition of the phytocoenoses of the *Hyperico grisebachii-Calamagrostietumvillosae* association by ecological categories of life formsis dominated by hemicryptophytes (68.93%) as the main components of subalpine meadows adapted to the excessively temperate continental climate specific to the Bihor-Vlădeasa Mountains geographical area.

Analysis of subalpine meadows by categories of phytogeographic elements (by geographical area) highlights a mixed picture in which Central European (15.53%), Circumpolar (13.59%), Alpine-Carpatho-Balkan (12.62%), Carpatho-Balkan (11.65%), European (11.65%), Eurasian (10.67%) species are present in similar proportions. Presence of Alpine-Carpatho-Balkan, Carpatho-Balkan, Arctic-Alpine (8.73%), Alpine (6.79%), Carpathian endemics (5.82%), Carpatho-Balkan-Caucasian (0.97%), Carpatho-Balkan-Anatolian (0.97%) species suggests the existence of phyto-historical connections and interferences of the flora of the Bihor-Vlădeasa Mountains with that of the Balkan Mountains south of the Danube, the Ukrainian Carpathians, the European Alps, and the Caucasus Mountains.

With regard to the spectrum of the chromosome karyotype (2n) the polyploids are the most numerous (39.8%) and instils the physiognomy of the association followed by diploids (35.9%), the unknown karyotype species (12.6), and diplopolyploids (11.65%).

Exhaustive studies on the phytocoenoses built by *Hypericum richeri* subsp. *grisebachii* and *Calamagrostis villosa*have not been carried outso far in the Apuseni Mountains, which is precisely why this association was described for the first time, as well as the subassociation *anemonetosum narcissifoliae* subas. nova, being communities characterized by floristic, ecological and physiognomic

individuality that vegetate in an intensely sunny habitat, sheltering a series of rare, vulnerable, endangered plants, natural monuments, endemics and relicts.

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