CONTRIBUTIONS TO THE KNOWLEDGE OF FLORA AND VEGETATION OF PEAT BOG FROM BIHORULUI MOUNTAINS (NW ROMANIA)

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Abstract. The oligotrophic peat bog of Bihorului Mountains are quartered in the valleys with northern exposure, of siliceous substrate, forming habitats with high conservation value, which are home to over 10 rare relict species. The phytocoenoses of the associations *Sphagnetum magellanici*, *Sphagno cuspidati – Rhynchosporetum albae, Caricetum limosae* were analyzed by us in terms of floristic composition, ecological spectra of the type of life forms and floristic elements, in terms of chart ecological factors: moisture, soil temperature and chemical reaction.

Keywords: phytocoenoses, association, peat bog, life forms, floristic elements, glacial relicts, Bihorului Mountains

INTRODUCTION

Under the general scheme of the Apuseni Mountains, the Bihorului Mountains, North-Western Romania, (Fig. 1) occupy a central position, forming the core of which is undoing orographic radial main branches of the Apuseni Mountains. Meanwhile, Bihorului Mountains is also a hydrographic center of major rivers that start divergent - Crişul Repede River at north to west, Someşul Cald River to east, Arieş River at south to east and Crişul Negru River to west. The peculiarity of these mountains is the presence of closed basins in the central area, developed through a complicated set of non-karstificable rocks (conglomerates, sandstones, purple shale) and karstificable, with underground drainage.

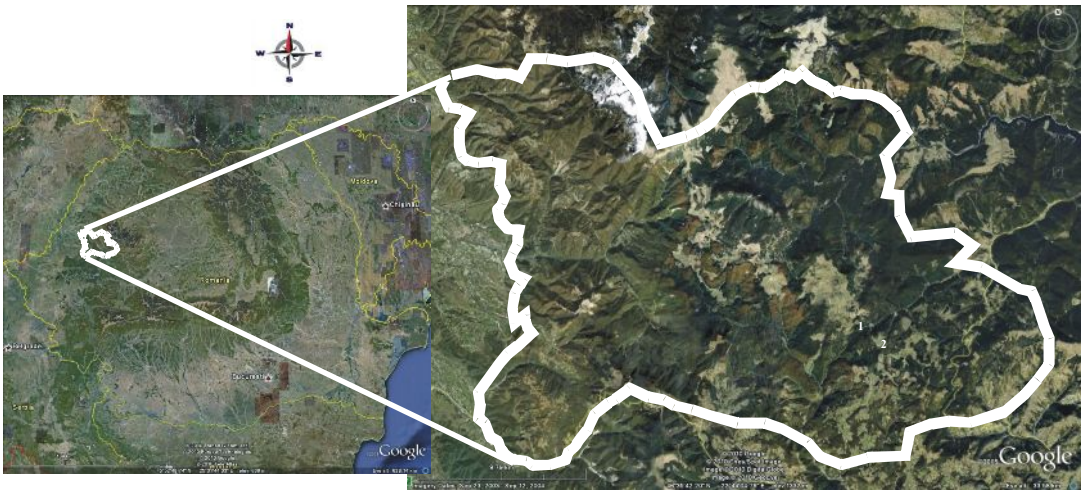

Figure 1. Bihorului Mountains (the framing zone). Source: own compilation by Google Earth software. Locations: 1 – Molhaşul Mare, 2 – Călineasa.

The climate of Bihorului Mountains is generally wet and cold; the vertical layer is manifested in all determinants of climate. Average annual air temperature is 2ºC in the northern and southern parts and 4ºC in the central limestone platform. In January, average air temperature is -7ºC in the high mountains and -3ºC in the valleys, while in July the average temperature recorded 10ºC. The prevailing wind is western, bringing rain and causing a large number of cloudy days. Annual rainfall in the highlands of Bihorului Mountains exceeds 1400 mm; the maximum amount in our country is found only in much higher mountains (Rodnei, Făgăraş and Retezat). For foothills, fall from an annual average rainfall of 800 mm.

These phenomena, combined with rock and terrain features that provide detailed changes and reversals due to local disturbance of the basement, climate and topography, have an important role in the distribution of vegetation in the Bihorului Mountains. Here are found very different plant species, some of the elements present on steep rock with southern exposition, are relicts of some hot climates, the tertiary, while others present in peat bog developed on the springs of northern valleys are relicts of cold climates, in times of glaciations age.

The peat bog from Bihorului Mountains, locally called "molhaş", develops in the valleys of springs of the Bătrâna, Călineasa, Trânghieşti, Someşul Cald rivers, located in the northern lowlands or with northern exposure. The peat bog of Molhaşul Mare area develops in the stream of Bătrâna brook on Izbucu Mare and Izbucu Mic springs, in a micro-U-shaped valley at an altitude of about 1050 m, over an area of about 80 ha. The peat bog from Valea Călineasa spring develops a plateau in northern exposure at an altitude of 1430 m, over an area of about 2-3 meters.

MATERIALS AND METHODS

The study of peat bog from Bihorului Mountains have used research methods of the Central European Phytosociology school based on the principles and methodology developed by Braun-Blanquet (1926) [2] and adapted by Borza and Boşcaiu (1965) [1] and Cristea et al. (2004) [10] to the features of vegetation cover in our country.

Phytosociological relevées made during the four study visits at the peat bog of Izbucul Călinesei and spring area of the brook Bătrâna during August-September 2009, included areas of homogeneous floristic and physiognomic evidence, which were chosen in the characteristic fragments of the studied phytocoenoses, their size ranging from 8 to 100 m^2.

Quantitative assessment of the participation of each species to describe associations was with the index of abundance - dominance (AD) after the evaluation system developed by Braun-Blanquet and Pavillard (1928) [3]. Association table contains information on species within the floristic composition of the association, life forms, floristic elements, ecological indices (moisture, temperature, chemical reaction of the soil), serial number of the relevées, altitude (MSM), exposition, inclination (degrees), the consistency of forest stands (%), herbaceous layer cover (%), area (m^2), place and date of reports. At the end of the table was entered and was calculated constancy (K) whose classes ranging from I to V expresses the degree of coenotic fidelity of each species to environment of phytocoenoses of the associations.

For completion of the environmental study of the associations, we have represented graphically the distribution of life forms, floristic elements and ecological factors.

RESULTS

Following field studies made in 2009 and investigations carried out by us on peat bog of the head of the Bătrâna brook (Bihor County) and of the Călineasa plateau of Izbucul Călineasa Valley (Alba County), we identified a total of three associations: ***Sphagnetum magellanici*, *Sphagno cuspidati – Rhynchosporetum albae*, *Caricetum limosae***, whose results on floristic composition and ecological analysis we present below.

1. Association ***Sphagnetum magellanici*** (Malcuit 1929) Kästner et Flössner 1933 (Syn.: *Eriophoro vaginati – Sphagnetum* Pop et al. 1987) *pinetosum mugi* Coldea et Plămadă 1989.

This association is mentioned in several location of the Eastern Carpathians and Moldova [5, 8, 17-19] and in the Western Carpathian Mountains [6-8, 12].

In the Bihorului Mountains this association has been identified by us in peatlands of the Molhaşul Mare peat bog from the head of Bătrâna brook (Izbucul Mare Valley, Bihor county) and the karst spring Călineasa Valley, on Călineasa plateau (Alba county, Fig. 2), both tributaries of the right of the Someşul Cald River.

The paludous phytocoenoses of the association *Sphagnetum magellanici* develop mainly in the central area of oligotrophic bogs studied by us, where there is excess moisture, giving rise to deposits 2-5 m thick peat soil and less to marginal zone, which is slightly summer. These phytocoenoses peat layer has a low mineral salts (1-1.5%) and a chemical reaction strongly acidic (pH = 3.5–4.8).

Figure 2. Aspects with ass. ***Sphagnetum magellanici*** from peat bog of the plateau of Izbucul Călineasa Valley (photo: Togor G., IX 2009).

Due to extreme climatic conditions (strong acid chemical reaction, the average annual temperature of 2ºC to 3°C, excess moisture), floristic composition of this association is confined to a small number of plants: 20 vascular plant species, representing 76% of flora inventory species and 6 bryophytes (of the genus *Sphagnum, Polytrichum, Pleurozium*) representing 24% of the flora of peat (Table 1).

Physiognomy of the association is given by *Sphagnum magellanicum* (with a high constancy K = IV, poor coverage in our mapped places, 0.5%), dominant and characteristic species of phytocoenoses of peat from Central Europe [14] and by *Sphagnum fuscum* with lush growth, forming thick layers of 3-5 m, maximum constancy (K = V), covering 80% of phytocoenoses of peat identified by us in Bihorului Mountains in northwestern Romania, with whom appears to a small area in 2 relevées (with K = II, coverage 0.5%) the mountain pine (*Pinus mugo*) as differential species of the sub-association *pinetosum mugi* Coldea, Plămadă 1989.

In the phytocoenoses of the peat described from Central Europe [14], the populations of *Pinus rotundata* are prevalent in trees layer, while *Pinus mugo* occurs sporadically or missing. The phytocoenoses of the Romanian peats are the sole enlightening in the shrub layer *Pinus mugo*, in the herbaceous layer *Eriophorum vaginatum*, *Carex pauciflora*, *Empetrum nigrum*, *Andromeda polifolia*, *Oxycoccus palustris*, with an average coverage of 70%, in moss layer *Sphagnum magellanicum*, *Sphagnum fuscum*, *Sphagnum fallax*, *Sphagnum angustifolium* with an average coverage of 80%.

In the floristic structure is distinguished hygrophilous and mezo-hygrophilous species characteristic to the alliance ***Sphagnion magellanici*** –

Eriophorum vaginatum, Carex pauciflora, Empetrum nigrum, to the order ***Sphagnetalia magellanici***, the class ***Oxycocco-Sphagnetea*** – *Andromeda polifolia, Oxycoccus palustris, Oxycoccus microcarpus, Drosera rotundifolia, Carex echinata, Carex rostrata, Juncus alpinus*. In this oligotrophic and ombrogenous association a small number of transgressive species entering from the class ***Vaccinio – Piceetea***: *Vaccinium myrtillus, Vaccinium vitis-idaea, Picea abies, Calluna vulgaris, Melampyrum sylvaticum.*

Table 1. Association ***Sphagnetum magellanici*** (Malcuit 1929) Kästner et Flössner 1933 (Syn.: *Eriophoro vaginati – Sphagnetum* Pop et al. 1987) *pinetosum mugi* Coldea et Plămadă 1989, in Bihorului Mountains.

L.f.	F.e.	U	T	R	Relevées	1	2	3	4	5	6	7	8	K
					Altitude (m.s.m)	1050	1050	1050	1050	1050	1050	1430	1430	
					Surface (m^2)	100	6	6	100	100	100	100	100	
					Herbaceous layer coverage (%)	70	60	60	80	40	80	80	80	
					Moss layer coverage (%)	75	75	90	90	100	100	75	100	
Brchs	Cp(bor)				*Ass. Sphagnum magellanicum*	1	1	+	2	+	+	.	.	IV
Brchs	Cp(bor)				*Ass. Sphagnum fuscum*	4	4	5	4	5	5	4	5	V
MPh	E(alp)	0	2	0	*Subass. Pinus mugo*	.	.	.	.	+	+	.	.	II
					Sphagnion magellanici									
H	Cp(bor)	4.5	0	1.5	*Eriophorum vaginatum*	+	+	+	1	+	1	1	1	V
Brchs	Cp				*Sphagnum fallax (S. recurvum)*	+	1	+	.	.	.	1	+	III
Brchs	Cp				*Sphagnum angustifolium*	1	.	+	.	+	+	.	.	III
H	Cp(bor)	5	2.5	1	*Carex pauciflora*	+	1	2	2	1	2	.	.	IV
nPh	Cp(arct-alp)	3.5	0	0	*Empetrum nigrum*	+	+	1	2	1	2	3	2	V
					Sphagnetalia magellanici, Oxycocco - Sphagnetea									
Ch	Cp(bor)	5	2.1	1	*Andromeda polifolia*	4	2	1	2	2	3	.	.	IV
Ch	Cp(bor)	5	0	2	*Oxycoccus palustris*	1	.	2	2	+	+	+	1	V
Ch	Bor	5	0	2	*Oxycoccus microcarpus*	+	.	+	.	.	.	.	+	II
H	Cp(bor)	5	2.5	1	*Drosera rotundifolia*	+	2	1	+	+	+	.	.	IV
Brchs	Cp(bor)				*Polytrichum strictum*	+	.	+	.	1	+	+	1	IV
H	Cp(bor)	5	2	1	*Carex echinata (C. stellulata)*	.	.	.	.	.	.	+	+	II
Hh	Cp(bor)	5	2	0	*Carex rostrata*	.	.	+	.	.	.	+	1	II
H	Cp(bor)	4	2	2	*Juncus alpinus*	.	.	.	.	.	.	+	.	I
					Vaccinio – Piceetea									
nPh	Cp(bor)	0	2	1	*Vaccinium myrtillus*	+	.	.	.	.	.	1	.	II
Ch	Cp(bor)	3	2	1	*Vaccinium vitis-idaea*	+	.	.	.	.	.	2	1	II
Ch	Atl(Ec)	0	0	1	*Calluna vulgaris*	.	2	1	1	.	.	1	3	IV
Th	Eua (mont)	3	0	1.5	*Melampyrum sylvaticum*	.	.	.	.	.	.	+	+	II
MPh	E	0	0	0	*Picea abies*	+	.	+	+	.	.	1	1	IV
Brchs	Cp(bor)				*Pleurozium schreberi*	.	.	.	.	.	.	+	+	II
					Variae Syntaxa									
H	Eua	4	3	0	*Molinia caerulea*	.	.	.	+	.	+	.	.	II
H	Eua	3.5	3	3	*Agrostis canina*	.	.	.	.	.	.	+	+	II
Th-TH	Cosm	3.5	0	0	*Poa annua ssp.varia*	.	.	.	.	.	.	+	.	I
H	Cp(bor)	5	0	2	*Epilobium palustre*	.	.	.	.	.	.	+	+	II

Note: Location and date: 1-2 Peatland Molhaşul Mare, on the brook Bătrâna - left bank, 25.08.2009, 3-4 Peatland Molhaşul Mare, on the brook Bătrâna - right bank, 25.08.2009, 5-6 Lake on peatland Molhaşul Mare, on the brook Bătrâna 08.10.2009; 7-8 Peatland Călineasa on the Călineasa Plateau 30.09.2009. H – Hemicryptophytes, Ch – Chamaephytes, MPh – Megaphanerophytes, nPh – Nanophanerophytes, Th – Therophytes, Hh – Helohydatophytes, Cp – Circumpolar, E – European, Bor – Boreal, Alp – Alpine, Atl – Atlantic, Ec – Central European, E – European, Eua – Eurasian, Mont – Mountain, Cosm – Cosmopolitan, Brchs - Bryophytes

The diagram of ecological factors (Fig. 3) highlight the preponderant participation in the referred association the hygrophilous species (U_5= 40%) followed by the mezo-hygrophilous ones ($U_{4-4.5}$= 15%), expression of a resort with a permanent excess of water. As most species are thermally microtherm ($T_{2-2,5}$= 45%), equal to the amphitolerant ones (T_0= 45%), expression of a microclimate with very cold ecotop (a short summer, cold, wet favorable to the physiological plant development, followed by a long winter, frosty, snowy, when the plants are in anabiosis). Depending on the chemical reaction of the soil, most species are strongly acidophilous (R_1= 45%), followed by ionic amphitolerant ones (R_0= 30%) and acidophilous species (R_2= 20%) expression of the colonization of peaty soils located acid substrate, peat bog accumulated in deposit not decompose but induce a greater acidity.

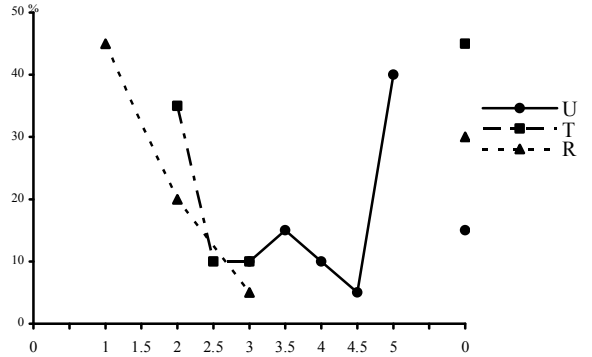

Figure 3. Diagram of ecological factors of ass. ***Sphagnetum magellanici*** in Bihorului Mountains (U – Humidity, T – Temperature, R – Chemical Reaction of the soil).

In the spectrum of the life forms (Fig. 4), the hemicryptophytes are found in large percentage (H = 40%) followed by chamaephytes (Ch = 25%), reflecting a habitat that gives them the best living

conditions and where they feel protected against the extreme conditions (during the summer heat, frost snowy winter) and they provide a constant fluid balance throughout the growing season.

In terms of floristic elements (Fig. 5), the predominant species are circumpolar (Cp = 60%) followed by the circumpolar-boreal and European-alpine species (E(Alp)+Bor = 15%) signifying an ecotop with a very cold and humid microclimate similar at the oligotrophic and ombrogene of postglacial marshes, where some species with arctic and circumpolar-boreal origin (glacial relicts) have found refuge until today.

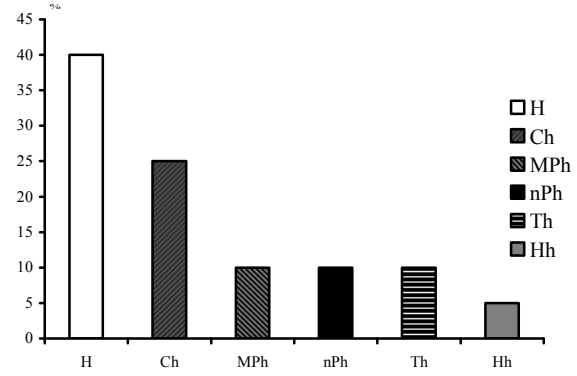

Figure 4. The life forms spectrum of ass. ***Sphagnetum magellanici*** in Bihor Mountains. (H – Hemicryptophytes, Ch – Chamaephytes, MPh – Megaphanerophytes, nPh – Nanophanerophytes, Th – Eutherophytes, Hh – Helohydatophytes).

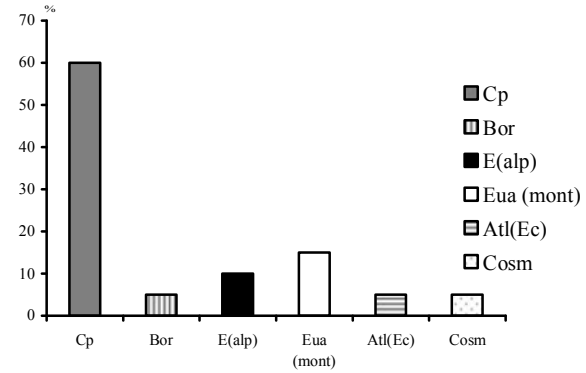

Figure 5. The spectrum of floristic elements of ass. ***Sphagnetum magellanici*** in Bihorului Mountains. (Cp – Circumpolar, Bor – Circumpolar Boreal, E(Alp) – European Alpine, Eua(mont) – Eurasian Mountain, Atl(Ec) – Atlantic Central European, Cosm – Cosmopolitan)

Because the peat bogs are poor nutritional mineral substances and chemical reaction is highly acidic, they have a poor and monotonous flora, with predominance of the bryophytes of the genus *Sphagnum* generating peat.

The peat of the peat bogs generated by oligotrophic, hygrophilous, microtherm and strongly acidophilous phytocoenoses, has multiple uses in the energy industry, chemical, pharmaceutical (therapeutic mud) in a mixture of soil for plant pots, in preparing nutritious substrate for cultivated mushrooms etc.

Due to high acidity, the thickness of peat layer (2-6 m) which was formed along the millennia, the peat bog have phytohistorical and phytogeographic importance, in the conservation of paleohistory information (preservation of pollen grains), allowing us rebuild the evolution of flora and local vegetation.

This is an association with many rare and relict species, representing remnants of the glacial period: *Carex pauciflora, Empetrum nigrum, Andromeda polifolia, Oxycoccus palustris, Oxycoccus microcarpus, Drosera rotundifolia*, which is why it must be effectively protected and free of any exploitation.

2. Association ***Sphagno cuspidati – Rhynchosporetum albae*** Osvald 1923 em. Koch1926

It is an extremely rare association whose phytocoenoses were described only on a few oligotrophic marshes in Bihorului Mountains to the Molhaşul Mare, in Vlădeasa Mountains to Călăţele [6], in Făgăraşului Mountains to the Mlaca Tătarilor, swamp Arpaşu de Sus [7, 17-19].

The paludous oligotrophic phytocoenoses of the association ***Sphagno cuspidati – Rhynchosporetum albae*** were identified by us as vegetating within lakes clogged the head of the Bătrâna brook (Fig. 6), on Izbucul Mare, right tributary of the Someşul Cald River (Bihor County). These lakes have a small area and water depth is only 5.7 cm in early summer and dry in autumn or very dry periods. The water of these lakes is poor in mineral nutrients and substances are a chemical reaction strongly acidic (pH 3.5-5).

Figure 6. Aspects with ass. ***Sphagnum cuspidati – Rhyncosporetum albae*** from peat bog of Molhaşul Mare (photo: Togor G. IX 2009).

Analyzed in terms of floristic elements and ecological factors, the phytocoenoses of *Rhynchospora alba* from the Romanian Carpathians belong to two subassociations. First one, *typicum* (Osvald 1923) Reichelt et Dierssen 1988, has fewer differential species for the class ***Scheuchzerio - Caricetea nigrae***, yet rich in diagnostic oligotrophic species of the order ***Sphagnetalia***, class ***Oxycocco - Sphagnetea***. The phytocoenoses identified by us in the Bihorului Mountains belong to this subassociation. They resemble those described in Central Europe [11, 16]. The phytocoenoses from the premontane area of Mlaca Tătarilor - Făgăraşului Mountains have a mezotrophic character and they belong to subassociation *caricetosum echinate* Coldea 1981, with the differential species: *Carex echinata*, *Carex nigra*, *Agrostis canina*.

Because of small surface of these lakes that are in advanced warping process, due to the extreme conditions of life generated by a specific habitat to high mountain floor with a very cold and humid microclimate, the phytocoenoses of this association include (Table 2) only 10 cormophytes species (73%) and 4 species of bryophytes (27%). The physiognomy of the association is given by two species: *Rhynchospora alba*, having the maximum constancy (K = V) in herbaceous layer synusia and average coverage amounts to 60% and *Sphagnum cuspidatum* with the maximum constancy (K = V), located in moss layer synusia, whose species account for an average coverage of 75%. Both edificator species are in co-dominant report.

In the floristic composition of the five relevées made by us, some hygrophilous species are distinguished, characteristic of the alliance, order and class ***Rhynchosporion albae, Scheuchzerio–Caricetalia nigrae, Scheuchzerio–Caricetea nigrae***: *Carex limosa, Drosera rotundifolia, Scheuchzeria palustris, Eriophorum scheuchzeri, Sphagnum angustifolium*. In this relict association penetrate a significant number of oligotrophic species, transgressive from class ***Oxycocco–Sphagnetea***: *Eriophorum vaginatum, Andromeda polifolia, Empetrum nigrum, Oxycoccus microcarpus, Carex pauciflora*.

Table 2. Ass. ***Sphagno cuspidati – Rhynchosporetum albae*** Osvald 1923 em. Koch 1926, in Bihorului Mountains.

L.f.	F.e.	U	T	R	Relevées	1	2	3	4	5	K
					Altitude (m.s.m)	1050	1050	1050	1050	1050	
					Surface (m^2)	25	25	25	12	16	
					Herbaceous layer coverage (%)	45	65	70	70	45	
					Moss layer coverage (%)	75	90	90	90	75	
H	Eua	5	0	2	*Ass. Rhynchospora alba*	3	4	4	2	3	V
Brchs	Cp				*Ass. Sphagnum cuspidatum*	4	5	5	5	4	V
					Rhynchosporion albae, Scheuchzerio-Caricetalia nigrae, Scheuchzerio-Caricetea nigrae						
H	Cp(bor)	5	2	1.5	*Carex limosa*	1	+	+	1	1	V
H	Cp(bor)	5	2.5	1	*Drosera rotundifolia*	+	+	+	+	+	V
G	Cp(bor)	5	2.5	2	*Scheuchzeria palustris*	.	.	.	1	+	II
H	Cp(arct-alp)	5	1.5	2.5	*Eriophorum scheuchzeri*	.	+	.	+	.	II
Brchs	Cp				*Sphagnum angustifolium*	.	.	+	.	1	II
					Oxycocco – Sphagnetea						
H	Cp(bor)	4.5	0	1.5	*Eriophorum vaginatum*	+	+	+	+	+	V
Ch	Cp(bor)	5	2.1	1	*Andromeda polifolia*	.	.	1	1	+	III
nPh	Cp(arct-alp)	3.5	0	0	*Empetrum nigrum*	.	.	.	.	+	I
Ch	Bor	5	0	2	*Oxycoccus microcarpus*	.	.	.	.	+	I
H	Cp(bor)	5	2.5	1	*Carex pauciflora*	+	.	.	+	+	III
Brchs	Cp(bor)				*Polytrichum strictum*	+	+	.	.	1	III
Brchs	Cp(bor)				*Sphagnum magellanicum*	1	+	.	.	.	II

Note: Locality and date: 1-2 Lake Molhaşul Mare, to the Observer, 8.10.2009; 3-5 Lake Molhaşul Mare, to the Bătrâna brook, 8.10.2009 H – Hemicryptophytes, Ch – Chamaephytes, G – geophytes, nPh – Nanophanerophytes, Cp – Circumpolar, Bor – Boreal, Alp – alpine, Arct – arctic, Eua – Eurasian, Brchs - Bryophytes

Diagram of ecological factors (Fig. 7) record the overwhelming dominance of hygrophilous species (U_5= 80%), followed by the mezo-hygrophilous ones ($U_{4,\ 5}$= 10%). In terms of heat, most species of described association are microtherm ($T_{2\text{-}2,\ 5}$= 50%), followed by heat amphitolerant species (T_0= 40%) and cryophilic ones (T_1= 10%), with an expression of an ecotop with a very cold and humid microclimate. Compared to the chemical reaction of the soil, most species of the association are strongly acidophilous (R_1= 50%) followed by acidophilous species (R_2= 40%), expression of peaty soils located on acid substrate. The peat is not decomposed, but it accumulates each year and causes great acidity.

Spectrum of life forms (Fig. 8) shows the overwhelming dominance of hemicryptophytes (60%), large distance followed by chamaephytes (20%).

The spectrum of floristic elements (Fig. 9) shows the categorically dominance of the circumpolar species (Cp = 80%) followed by the circumpolar-boreal ones (Bor = 10%), expression of a very cold and humid microclimate, in a somewhat similar to that of the oligotrophic and ombrogenous marshes of postglacial.

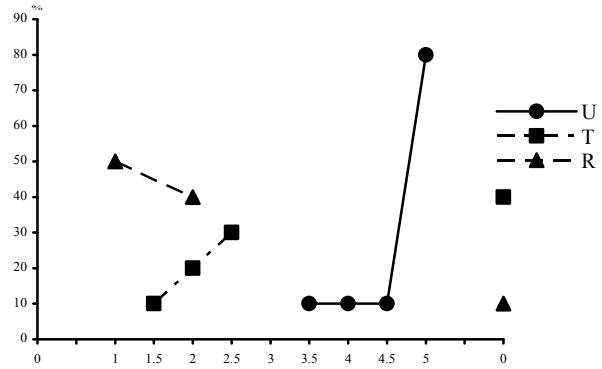

Figure 7. Diagram of ecological factors of ass. ***Sphagno cuspidati – Rhynchosporetum albae*** in Bihorului Mountains (U – Humidity, T – Temperature, R – Chemical Reaction of the soil).

The ass. ***Sphagno cuspidati – Rhynchosporetum albae*** is a relict association, surviving in this land from the post-glacial period. Because it is composed by a large number of rare and relict species (*Rhynchospora alba, Carex limosa, Drosera rotundifolia, Scheuchzeria palustris, Andromeda polifolia, Empetrum nigrum, Oxycoccus microcarpus, Carex*

pauciflora) it must be effectively protected with its natural environment.

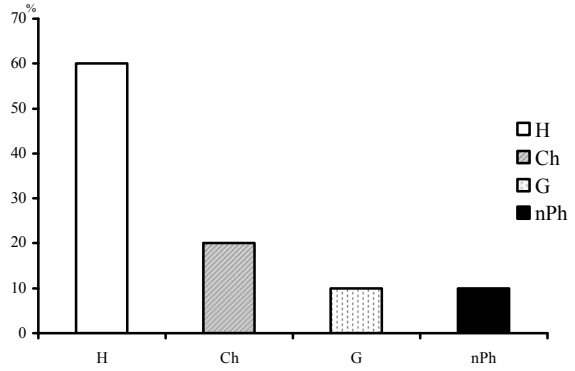

Figure 8. The life forms spectrum of ass. ***Sphagno cuspidati – Rhynchosporetum albae*** in Bihorului Mountains (H – Hemicryptophytes, Ch – Chamaephytes, G – Geophytes, nPh – Nanophanerophytes).

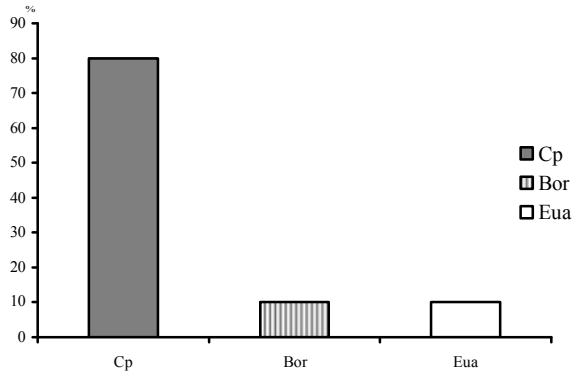

Figure 9. The spectrum of floristic elements of ass. ***Sphagno cuspidati – Rhynchosporetum albae*** in Bihorului Mountains (Cp – Circumpolar, Bor – Circumpolar-Boreal, Eua – Eurasian)

3. Association ***Caricetum limosae*** Br.-Bl.1921 (*Syn.: Carici limosae – Sphagnetum* Resmeriţă 1973)

It is a rare association in our country, whose phytocoenoses were identified and analyzed in several oligotrophic mountain swamps (900-1100 m) of the Eastern Carpathians Mountains [5, 6, 17-19], the Western Carpathians [6, 15].

Paludous, oligotrophic phytocoenoses of this association have been identified by us in Bihorului Mountains, as vegetating in shallow (10–15 cm) and highly acidic soils (pH 3.5–4.2), poor in mineral nutrients, in the lakes located at the head of the Bătrâna brook, on Izbucul Mare Valley (Bihor County), known as well as "Molhaşul Mare de la Izbuce". The phytocoenoses of this association includes a total of 12 vascular plant species (75%) and 4 species of bryophytes (25%). Physiognomy of the association is given by the characteristic species *Carex limosa* with an average coverage of 50%, maximum constancy (K = V), located in herbaceous layer synusia and the species *Sphagnum cuspidatum* with the medium coverage of 65%, maximum constancy (K = V) in moss layer synusia.

In the floristic composition of the five relevées (Table 3) made by us in Bihorului Mountains, differential species for alliance ***Rhynchosporion albae,*** order ***Scheuchzerio–Caricetalia*** and class ***Scheuchzerio–Caricetea*** are quite well represented: *Drosera rotundifolia, Lycopodium inundatum, Eriophorum scheuchzeri, Sphagnum cuspidatum, Sphagnum rusowii*. In the referred association, they are held a number of six glacial relict species, transgressive

Table 3. Ass. *Caricetum limosae* Br.-Bl.1921 (*Syn.: Carici limosae – Sphagnetum* Resmeriţă 1973), in Bihorului Mountains.

L. f.	F. e.	U	T	R	Relevées	1	2	3	4	5	K
					Altitude (m.s.m)	1050	1050	1050	1050	1050	
					Surface (m^2)	25	50	100	8	8	
					Herbaceous layer coverage (%)	65	65	45	40	40	
					Moss layer coverage (%)	65	70	75	65	65	
H	Cp(bor)	5	2	1.5	Ass. *Carex limosa*	4	4	3	3	3	V
					Rhynchosporion albae, Scheuchzerio – Caricetalia, Scheuchzerio – Caricetea						
H	Cp(bor)	5	2.5	1	*Drosera rotundifolia*	+	+	+	+	+	V
Ch	Cp(bor)	5	2.5	1	*Lycopodium inundatum*	.	.	.	.	+	V
					Sphagnum cuspidatum	4	4	4	4	4	V
					Sphagnum rusowii	+	.	1	.	+	III
H	Cp(arct-alp)	5	1.5	2.5	*Eriophorum scheuchzeri*	.	.	+	.	.	I
					Oxycocco – Sphagnetea						
H	Cp(bor)	5	2.5	1	*Carex pauciflora*	+	+	1	+	.	IV
H	Cp(bor)	4.5	0	1.5	*Eriophorum vaginatum*	.	.	+	.	+	II
Ch	Cp(bor)	5	2.1	1	*Andromeda polifolia*	+	+	.	.	.	II
nPh	Cp(arct-alp)	3.5	0	0	*Empetrum nigrum*	.	+	.	+	.	II
Ch	Cp(bor)	5	0	2	*Oxycoccus palustris*	.	.	.	.	+	I
Ch	Bor	5	0	2	*Oxycoccus microcarpus*	+	.	.	.	.	I
					Polytrichum strictum	+	+	1	.	.	III
					Sphagnum magellanicum	1	.	+	+	.	II
					Variae Syntaxa						
Hh	Cp(bor)	5	2	0	*Carex rostrata*	.	.	.	+	.	I
H	Eua	4	3	0	*Molinia caerulea*	.	.	.	.	+	I

Note: Locality and date: 1-2 Lake Molhaşul Mare, to Observer, 8.10.2009; 3-5 Lake Molhaşul Mare, to Bătrâna brook, 8.10.2009. H – Hemicryptophytes, Ch – Chamaephytes, nPh – Nanophanerophytes, Cp – Circumpolar, Bor – Boreal, Alp – alpine, Arct – arctic, Eua – Eurasian, Brchs - Bryophytes

from class ***Oxycocco–Sphagnetea***: *Carex pauciflora, Andromeda polifolia, Empetrum nigrum, Oxycoccus palustris, Oxycoccus microcarpus, Eriophorum vaginatum*. This suggests the evolution of that association toward phytocoenoses of the alliance ***Sphagnion magellanici***, that are similar to

phytocoenoses described in Central Europe by Duvigneaud (1949) [13].

Specific ecological conditions of life (Fig. 10) give to the association a preponderant hygrophilous character (U_5= 75%), to weak mezo-hygrophilous ($U_{4-4,5}$= 16.6%). Compared to temperature, the present species are micro-therm ($T_{2-2,5}$ = 50%), followed by heat amphitolerant ones (T_0= 33.3%), signifying the membership to an ecotop with very cold and humid microclimate. Regarding the chemical reaction of the soil, the dominant species are strong acidophilous (R_1= 50%), followed by the acidophilous (R_2= 25%) and the amphitolerant species (R_0= 25%).

The spectrum of life forms (Fig. 11) reveals the dominance in association of hemicryptophytes species (H = 50%), followed by chamaephytes (Ch = 33.3%), suggesting the affiliation to a habitat with constant and optimal living conditions, free from unfavorable extremes.

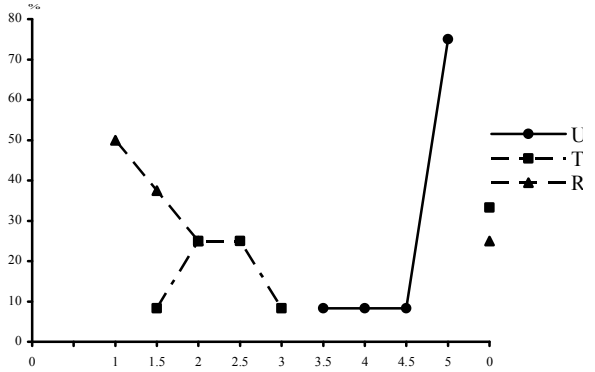

Figure 10. Diagram of the ecological factors of ass. *Caricetum limosae* in Bihorului Mountains. (U – Humidity, T – Temperature, R – Soil Reaction).

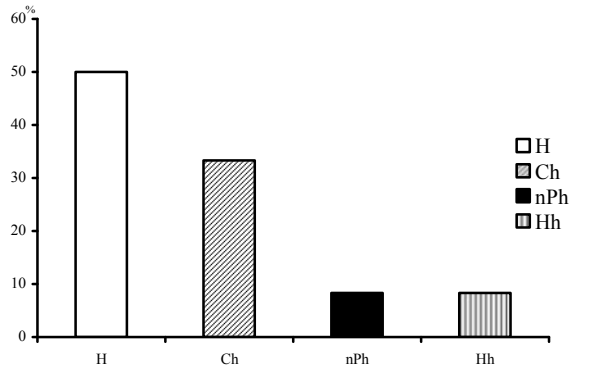

Figure 11. Spectrum of life forms of the ass. *Caricetum limosae* in Bihorului Mountains. (H – Hemicryptophytes, Ch – Chamaephytes, nPh – Nanophanerophytes, Hh – Helohydatophytes).

The floristic elements spectrum (Fig.12) shows the categorically dominance of circumpolar species (Cp = 83.3%), followed by the circumpolar-boreal ones (Bor = 8.3%), suggesting the genetic affiliation to the oligotrophic and ombrogene swamps of post-glacial.

This association is very rare in our country. In their phytocoenoses there are preserved many glacial relict species, rare, endangered, scientifically important, such as *Carex limosa, Drosera rotundifolia, Lycopodium*

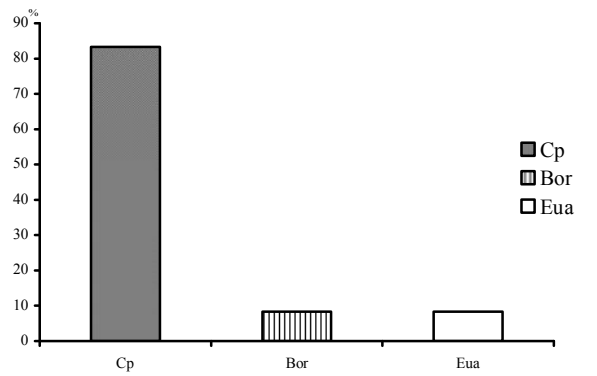

Figure 12. Spectrum of floristic elements of ass. *Caricetum limosae* in Bihorului Mountains (Cp – Circumpolar, Bor – Circumpolar Boreal, Eua – Eurasian).

inundatum, Carex pauciflora, Andromeda polifolia, Empetrum nigrum, Oxycoccus palustris, Oxycoccus microcarpus. It should be effectively protected with its natural environment.

DISCUSSIONS

Regarding the association ***Sphagnetum magellanici***, if we compare (Table 4) the phytocoenoses of the peat bogs studied by us in Bihorului Mountains and investigated by Coldea and Plămadă (1989) [8] in peat lands of Căpățânii Mountains, we observe the following:

- The behavior of the phytocoenoses of the association from the Bihorului Mountains, regarding into life forms show the dominance of hemicryptophytes (40%), followed far from the chamaephytes (25%), while in the Căpățânii Mountains the life forms are dominated by chamaephytes (44%), followed closely by the hemicryptophytes (33%). The analyzed behavior of life forms suggests a certain stability of phytocoenoses of ***Sphagnetum magellanici*** association that develops in peat lands in Bihorului Mountains, dominated by the species from genus *Sphagnum* and a tendency of instability with an evolution to thickets consisting of species from genus *Vaccinium, Oxycoccus, Andromeda, Empetrum*, in the phytocoenoses of peat bogs from the Căpățânii Mountains.
- The behavior of phytocoenoses of the association ***Sphagnetum magellanici*** regarding into the balance of floristic elements means the dominance of the circumpolar species - 66% in the Bihorului Mountains and 77% in the Căpățânii Mountains, followed by boreal species - 5% in the Bihorului Mountains and 11% in the Căpățânii Mountains. This phenomenon is explained by the altitude difference in which the phytocoenoses are developed, 1050 m in Bihorului Mountains and 1600 m in Căpățânii Mountains.
- As regards the biodiversity of the association ***Sphagnetum magellanici***, it is higher in the Bihor Mountains, amounting to a total of 26 taxa due to migration of species from the forest area and phytocoenological associations resulting from the exploitation of the forests, while in the Căpățânii Mountains the phytocoenoses of the association have a lower biodiversity (only 14 taxa), a phenomenon

explained by the trend towards to phytocoenoses of forest association.

- Analyzing the floristic composition of the association ***Sphagnetum magellanici*** regarding the constancy of species (K) and abundance-dominance (AD), we find that a maximum or high constancy (K=V, IV) and a maximum or large abundance-dominance (AD = 5, 4) have woody undershrub species belonging to genus *Oxycoccus*, *Empetrum*, *Andromeda*, *Vaccinium*, characteristic to phytocoenoses of peats from Căpăţânii Mountains. Also, maximum or high constancy (K = V, IV), maximum, large or increased abundance-dominance (AD = 5, 4, 3), we find to the herbaceous species belonging to the genus *Sphagnum, Eriophorum, Carex, Drosera, Polytrichum, Pleurozium*, characteristic to phytocoenoses of peats from Bihorului Mountains.

Table 4. The floristic composition of ass. ***Sphagnetum magellanici*** (Malcuit 1929) Kästner et Flössner 1933 (Syn.: *Eriophoro vaginati – Sphagnetum* Pop et al. 1987) *pinetosum mugi* Coldea et Plămadă 1989, in two geographical regions: Bihorului Mountains and Căpăţânii Mountains.

			Bihorului Mountains	**Căpăţânii Mountains***
		Year	**2009**	**1988**
		Number of relevées	**8**	**8**
		Number of species	**26**	**14**
L.f.	**F.e.**	**Altitude (m.s.m)**	**1050**	**1600**
Brchs	Cosm	*Ass. Sphagnum magellanicum*	IV, 1	V,1
Brchs	Cp	*Ass. Sphagnum fuscum*	V,5	V,4
MPh	E(alp)	*Subass. Pinus mugo*	II,+	.
		Sphagnion magellanici		
H	Cp(bor)	*Eriophorum vaginatum*	V,1	V,2
H	Cp(bor)	*Carex pauciflora*	IV,2	V,1
nPh	Cp(arct-alp)	*Empetrum nigrum*	V,2	IV,1
Brchs	Cp	*Sphagnum fallax (S.recurvum)*	III,+	.
Brchs	Cp	*Sphagnum angustifolium*	III,+	I,+
		Sphagnetalia magellanici, Oxycocco - Sphagnetea		
Ch	Cp(bor)	*Andromeda polifolia*	V,3	V,1
Ch	Cp(bor)	*Oxycoccus palustris*	V,2	.
Ch	Bor	*Oxycoccus microcarpus*	II,+	V,1
H	Cp(bor)	*Drosera rotundifolia*	IV,+	II,+
Brchs	Cp(bor)	*Polytrichum strictum*	IV,+	IV,+
Brchs	Cosm	*Sphagnum rubellum*	.	II,+
H	Cp(bor)	*Carex echinata (C.stellulata)*	II,+	.
Hh	Cp(bor)	*Carex rostrata*	II,+	.
H	Cp(bor)	*Juncus alpinus*	I,+	.
		Vaccinio – Piceetea		
nPh	Cp(bor)	*Vaccinium myrtillus*	II,+	II,+
Ch	Cp(bor)	*Vaccinium vitis-idaea*	II,+	II,+
Ch	Atl(Ec)	*Calluna vulgaris*	IV,1	.
Th	Eua(mont)	*Melampyrum sylvaticum*	II,+	II,+
MPh	E	*Picea abies*	IV,+	.
Brch	Cp(bor)	*Pleurozium schreberi*	II,+	.
		Variae Syntaxa		
H	Eua	*Molinia caerulea*	II,+	.
H	Eua	*Agrostis canina*	II,+	.
Th-TH	Cosm	*Poa annua ssp.varia*	I,+	.
H	Cp(bor)	*Epilobium palustre*	II,+	.

Note: Constancy or presence of the species (K): V = 81-100%, IV = 61-80%, III = 41-60%, II = 21-40%, I = 1-20%; Abundance–Dominance or soil coverage by species: 5 = 87,5%, 4 = 62,5%, 3 = 37,5%, 2 = 17,5%, 1 = 5%, + = 0,5%. * From Coldea et Plămadă (1989) [8].

Regarding the association ***Sphagno cuspidati - Rhynchosporetum albae,*** if we compare phytocoenoses investigated by us in the oligotrophic peat bogs in Bihorului Mountains (Western Carpathians) with phytocoenoses of mezo-oligotrophic swamp marsh Mlaca Tătarilor in the Făgăraş Mountains (Southern Carpathians), researched by Coldea and Plămadă (1989) [6], we found that:

- The behavior of the phytocoenoses of the association towards the balance of life forms share the overwhelming dominance of the hemicryptophytes species (71%) in swamp Mlaca Tătarilor and 60% in peat bogs of Bihorului Mountains, followed by chamaephytes species, 20% in peat bogs of Bihorului Mountains and only 9% in swamp Mlaca Tătarilor.
- The behavior of the studied phytocoenoses towards the floristic elements suggest the domination of the circumpolar species (80%), followed by the boreal ones (10%) in the oligotrophic peat bogs of Bihorului Mountains, compared with the mezo-oligotrophic swamp Mlaca Tătarilor, where the paludous phytocoenoses of the association are dominated by circumpolar species in a smaller percentage, only 66%, followed by Eurasian species (19%).
- Lower weight of the circumpolar elements and the penetration of Eurasian species in the phytocoenoses of the swamp Mlaca Tătarilor is explained by large difference of the altitude, correlated to the stationary environmental factors, between the two localities, 1050 m in Bihor Mountains and only 520 m in Mlaca Tătarilor, Făgăraş Mountains.
- The phytocoenoses of the association ***Sphagno cuspidati - Rhynchosporetum albae*** totalize a number of 21 taxa in swamp Mlaca Tătarilor in Făgăraş

Mountains with a relatively high biodiversity (Table 5), compared with peat bogs of Bihorului Mountains, where have been identified a number of 14 taxa, meaning a smaller biodiversity.

- As regards the constancy of species, in the paludous phytocoenoses of Mlaca Tătarilor a number of 9 species have maximum constancy (K = V) representing a percentage of 43% of the total, followed by those with average constancy (K = III), representing a percentage of 19%. In the oligotrophic phytocoenoses of the peat bogs of Bihorului Mountains, a number of 5 species (representing 36%) have a maximum constancy, followed by those with an average constancy (K = III), representing 28%. The higher percentages regarding the maximum and average constancy of species in the mezo-oligotrophic phytocoenoses of swamp Mlaca Tătarilor means that, in the syndynamics of the association evolution, they approaching an ecological optimum, unlike the species of the oligotrophic phytocoenoses of the peat bogs of Bihorului Mountains, which are in process of colonization and development, yet without reaching an ecological optimum.

Table 5. The floristic composition of ass. ***Sphagno cuspidati – Rhynchosporetum albae*** Osvald 1923 em. Koch 1926 *caricetosum echinatae* Coldea et Plămadă 1980, in the two geographical regions: Bihorului Mountains and Făgăraşului Mountains.

			Bihorului Mountains	Făgăraşului Mountains*
		Year	2009	1980
		Number of relevées	5	5
		Number of species	14	21
L.f.	F.e.	Altitude (m.s.m)	1050	520
H	Eua	*Ass. Rhynchospora alba*	V,3	V
		Ass. Sphagnum cuspidatum	V,4	.
H	Cp(bor)	*Subass. Carex echinata (C. stellulata)*	.	V
G	Cp(bor)	*Carex nigra*	.	III
		Rhynchosporion albae, Scheuchzerio-Caricetalia nigrae, Scheuchzerio-Caricetea nigrae		
H	Cp(bor)	*Carex limosa*	V,1	.
H	Cp(bor)	*Drosera rotundifolia*	V,+	V
H	Cp(bor)	*Scheuchzeria palustris*	II,+	.
H	Cp(arct-alp)	*Eriophorum scheuchzeri*	II,+	.
G	Cp(bor)	*Eriophorum gracile*	.	III
Brchs	Cp(bor)	*Sphagnum angustifolium*	II,+	.
Brchs	Cosm	*Sphagnum contortum*	.	III
Hh	Cp(bor)	*Menyanthes trifoliata*	.	IV
H	E	*Carex lepidocarpa*	.	V
H	Cp(bor)	*Juncus alpinus*	.	II
H	Eua	*Agrostis canina*	.	II
		Drepanocladus revolvens	.	I
		Aulacomnium palustre	.	I
		Oxycocco – Sphagnetea		
H	Cp(bor)	*Eriophorum vaginatum*	V,+	V
Ch	Cp(bor)	*Andromeda polifolia*	III,1	.
nPh	Cp(arct-alp)	*Empetrum nigrum*	I,+	.
Ch	Bor	*Oxycoccus microcarpus*	I,+	.
H	Cp(bor)	*Carex pauciflora*	III,+	.
Brchs	Cp(bor)	*Polytrichum strictum*	III,+	II
Brchs	Cosm	*Sphagnum magellanicum*	II,+	V
		Variae Syntaxa		
H	Eua	*Molinia caerulea*	.	V
H	Eua(M)	*Potentilla erecta*	.	V
H-Hh	Cosm	*Lythrum salicaria*	.	V
H	Cp(bor)	*Agrostis stolonifera*	.	III
Brchs	Cp(bor)	*Sphagnum capillifolium (S.acuti)*	.	II
Brchs	Cosm	*Sphagnum centrale*	.	II

Note: Constancy or presence of the species (K): V = 81-100%, IV = 61-80%, III = 41-60%, II = 21-40%, I = 1-20%; Abundance–Dominance or soil coverage by species: 5 = 87,5%, 4 = 62,5%, 3 = 37,5%, 2 = 17,5%, 1 = 5%, + = 0,5%. * Data from Coldea et al. (1997) [9].

The paludous, oligotrophic, strongly acidophilous phytocoenoses identified by us in the Bihorului Mountains, the Călineasa Valley (Alba County) and Bătrâna brook (Bihor County) belong to associations that are considered relict, surviving in this territory since the ice age.

The phytocoenoses of the associations ***Sphagnetum magellanici, Sphagno cuspidati – Rhynchosporetum albae, Caricetum limosae*** analyzed by us in peat peat moss of Bihorului Mountains, have in their floristic composition a number of ten rare species, glacial relict and red listed as endangered, vulnerable species: *Andromeda polifolia, Carex limosa, Drosera rotundifolia, Empetrum nigrum, Rhynchospora alba, Scheuchzeria palustris, Sphagnum fuscum, S. magellanicum, S. recurvum, S. angustifolium* . These types of habitats, with very high conservative value, are listed as priority in European classification of habitats (EMERALD, Corine, EUNIS, Palearctic Habitats, Nature 2000) [12, 20]. The two areas studied by us are included in the special conservation area in the Apuseni Natural Park and the peat bog of

"Molhaşul Mare de la Izbuc" have status of scientific reserve. But it is necessary to effective protection of these very sensitive areas by establishing continuous and careful monitoring and a system of protection of the administrative and scientific institutions.

In addition to scientific content, we want our work to have a protective effect in educating citizens in the spirit of ecological behavior towards nature.

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