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Patterns of vegetation diversity of grasslands and pastures – Crvanj Mt. (Herzegovina, Western Balkan)

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This paper represents study results of patterns of structure and dynamics of grasslands and pastures communities on vertical profile of Crvanj Mt. in Herzegovina (W. Balkan. Investigated area is situated between co-ordinates N 43° and 43°30' and E 18° and 18°30'. From the orography point of view, the area is very heterogenous. It encompases numerous peaks, valleys, passages and diverse karst formations. The highest peak is Zimomor (1920 m), while the lowest point is Ulog (670 m). The area is also very heterogenous from standpoint of geology. Thus, here occur marls, calcarenits, limestones, sandstones and dolomites. From division of automorphous soils it occur calcocambisol, calcomelanosol and luvisol on limestone, while distric cambisol and ranker occur on ingenious rocks. The most frequent among hydromorphous soils here are pseudogley, eugley, histosol (peat) and fluvisol. Ecoclimate is humid and perhumid, and in terms of temperature it is moderately warm to moderately cold. Mean annual temperature varies between 8.5°C on the foot of mountain and 2.0°C in the highest zone. Annual precipitation is 1700 mm, reaching maximum values in autumn and winter. Detected are grassland and pasture communities belonging to nine different alliances, five orders and three classes. It is described new community *Asphodelo-Agrostietum capillaris* Redzic ass. nova hoc loco from the alliance *Festuco-Agrostion capillaris,* order *Festuco-Agrostietalia* and community of *Scillo litardierei-Molinietum coeruleae Redzic ass. nova hoc loco of the* class *Molinio-Arrhenatheretea* and community *Eriophoro latifolii-Menyanthetum trifoliati* Redzic ass. nova hoc loco from the alliance *Caricion davallianae,* order *Caricetalia davallianae* of the class *Scheuchzerio-Caricetea fuscae*. Other important communities are endemic and relict, such as: *Carici caryophyllei-Scabiosetum leucophylae, Bromo-Plantaginetum mediae „subalpinum“, Saturejo-Edraianthetum, Danthonio-Scorzoneretum villosae, Molinietum coeruleae„ illyricum“* and *Hypochoereto-Crepidetum conyzifoliae*.

Key words: Biodiversity, syntaxonomy, habitat classification, wetland, calcareous grasslands, Dinaric Alps.

INTRODUCTION

Grassland communities are extremely important part of the entire biodiversity and deserve therefore full attention and protection of modern mankind (CBD, 1992). Especially because of the fact that large part of grassland and pasture ecosystems has been degraded and transformed into low woodland and shrubs, or agricultural and urban ecosystem types. There has allready been recorded significant lost in the entire biodiversity due to these changes. Grassland communities take an important place within European biodiversity (Borhidi, 1996; Vittoz, 2002; Rodwell et al., 2002; Biondi et al., 2005; Redzic, 2007a, b;

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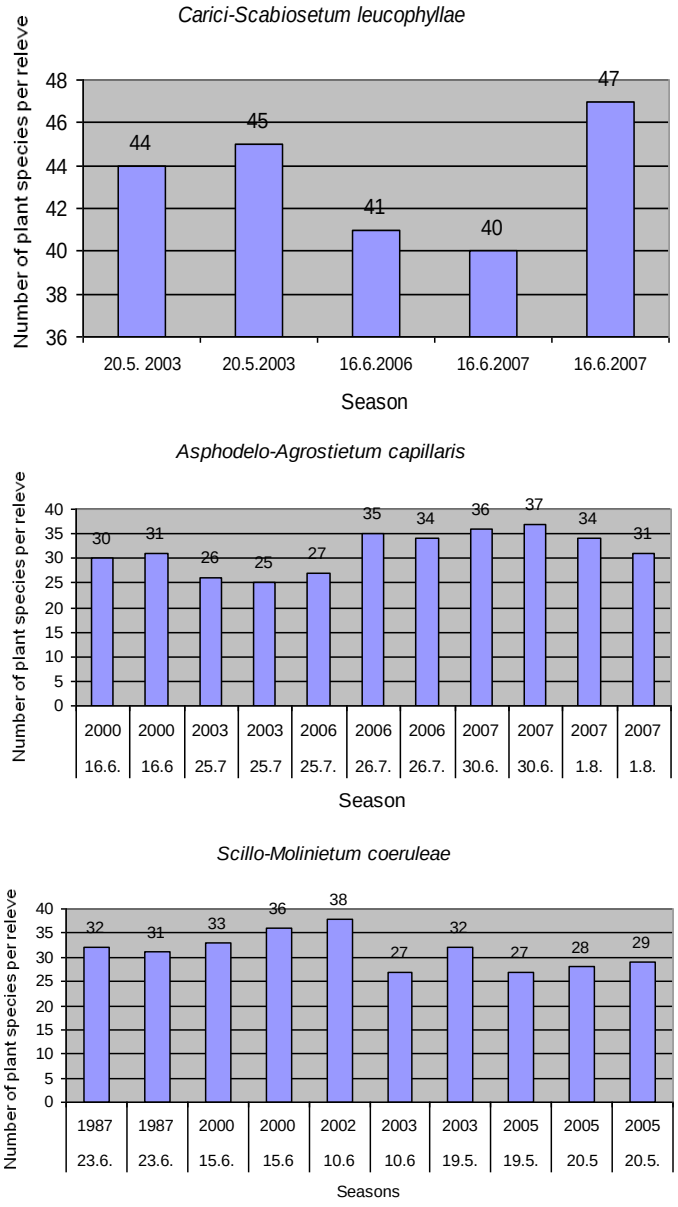

Figure 1. Geographic position of investigated area (In Attachment).

Geven et al., 2009, 2010; Mysliwy and Bosiacka, 2009; Kleinebecker et al., 2010). Special care and attention deserve meadows on carboniferous substrata which are composed of a lot of species which makes them extremely important in terms of European biodiversity and habitat maintainance (EUNIS, 2010). In orded to protect grassland biodiversity it is required to undertake investigation of these vegetation types of any area, and especially of those that have been poorly or unsufficiently investigated. Such area is massif of Crvanj Mt. positioned in northern part of East Herzegovina.

Vegetation studies in this geographic region still have outstanding trend and neccesity, considering various aspects, such as classification, understanding of their structure and dynamics, and modern investigations of syntaxonomy (Micevski, 1994; Maccherini et al., 2000; Bruun and Ejrnaes, 2000; Grabherr et al., 2003; Tsiripidis et al., 2005; Peinado et al., 2005; Bültmann, 2005). Particular attention has been paid to the modern synthetic investigations and syntaxonomical revision and objectification of certain types of vegetation, or vegetation complexes in both neighbouring and wider geographical regions (Grabherr et al., 1993; Stevanović et al., 1995; Solomakha, 1996; Čarni, 1997; Sardinero, 2002; Surina and Dakskobler, 2005; Stancic, 2007; Zelnik and Carni, 2008; De Caceres and Legendre, 2009; Hroudova et al., 2009; Wagner, 2009).

Particular attention of previous investigations in phytogeography and classification of vegetation has been paid to the western Balkan (Fiala, 1889; Adamović, 1907; Fukarek, 1954, 1969; Fukarek and Stefanović, 1958; Horvat et al., 1974; Blečić and Lakušić, 1976; Jovanović et al., 1986; Dizdarević et al., 1979).

There were several attempts of phytogeographical differentiation and analysis of vegetation in previous phytocoenological investigations in the region of the western Balkan, and even whole Balkan Peninsula (Horvat, 1939; 1960, 1962; Lakušić, 1969, 1970; Lakušić et al., 1978, 1979, Lakušić, 1970; Stancic, 2005, 2008).

In previous period massif of Crvanj Mt. has drawn attention of numerous natural scientists and florists. In the area have investigated Ami Boue, Otto Blau, Jozef Pantocsek together with Armin Knapp (Fukarek 1954), then Pichler, Formanek (Beck-Mannagetta, 1909), Adamović (1889), Maly (1933), Beck-Mannagetta (1903, 1916), Janchen (1906), Šilić (1990) and others.

Results on investigation of wood vegetation, as well as of alpine and pre-alpine grasslands and plant communities around sheepfolds on Crvanj Mt., due to its volume were published in separate papers (Redžić, 2000, 2010). This contribution represents detailed analysis of grasslands and pastures in mountainous and lower part of upland's belt on mentioned mountain.

Main objectivs of this paper are: (i) revelation of structure (floristic composition) and dynamics of the most often occuring grassland communities in mountainous and upland belt on the pattern of vegetation of Crvanj Mt. (ii) phytocoenological analysis of grasslands and pastures, including swampy habitats, according to the methodology which is accepted by international scientific community, determination of plant communities and their habitats and (iii) analysis of communities in terms of phytogeography and syndynamics, and estimation of their significance in the regional biodiversity.

General characteristics of investigated area

The morphostructure of Mt. Crvanj is situated in eastern Herzegovina (Figure 1). Its extension directions are north-northwest and south-southeast which does not correspond to the extension direction of most Dinaric

Table 1. Some characteristics of eco-climate of Crvanj Mt. (Herzegovina, W. Balkan) (Values for precipitations and air temperature are according to Meteorological Station of Kalinovik).

Eco-climatic parameter	Month												Annual
	I	II	III	IV	V	VI	VII	VII	IX	X	XII	XII	value
Precipitation (mm)	83	87	80	83	102	96	72	68	91	130	159	167	1218
Air temperature (°C)	-2.2	-1.1	2.0	6.7	11.2	14.8	16.8	16.9	13.4	8.7	4.6	0.4	7.1
Rain factor (RF)	_	_	40.0	12.4	9.1	6.5	4.3	4.0	6.8	14.9	34.6	417.5	171.6
Humidity*	ph	ph	ph	h	h	sh	sa	sa	h	ph	ph	ph	ph
Heat character of eco-climate**	n	n	c	mc	mw	w	w	w	w	mw	mc	n	mc

Humidity*: ph – per-humid h – humid sh – semi-humid sa - semi-arid. Heat character of eco-climate**: n – nival (snow) c – cold mc – moderate cold mw – moderate warm w – warm.

massifs. The Crvanj Mt. is being part of high karst region with the highest peak Zimomor (1920 m). Its northern area has got well developed hydrologic surface network while southern area hasn't (Katzer, 1926; Spahić, 1984).

In mountainous and upland belts, from Ulog (670 m) to Bačko or Uloško Lake (1050 m), dominate shale and calcarenit making connection to the formations of marl and limestone along with hornstone. As far as soil types concerns, in the area occur calcomelanosol, calcocambisol, district cambisol and partially luvisol. Around Uloško Lake itself are to be found morena depositions, marl, sandstone, marly limestone and feldspars. This kind of substrata is foundation for swampy gley, eugley and boggy basophilous soil type and luvisol occurs on the localities that are being exposed to the weak influence of underground water.

Added data (Table 1) illustrate relative strong impacts of maritime climate in terms of precipitation quantity and distribution for the stations of Kalinovik. More continental influences prevail in the area around Kalinovik. Regarding humidity, climate is per humid on every station, where as during vegetation season it is semiarid, arid and semi humid, being therefore, in terms of temperature regime, moderately cold. During vegetation season, climate is warm and moderately warm (Table 1).

Relative air humidity varies between 75 and 80% over the entire year, and during vegetation season it varies from 58 to 76% (Redžić et al., 1992-95). Mean annual cloudiness varies between 51 and 63% (Redžić, 2000). According to Milosavljević (1973), climate of the investigated belts on Crvanj Mt. is pre-mountainous with strong maritime impact. Ascending on the vertical profile, climate gains typical mountainous character, where as climate is even mild alpine on its highest peaks.

In phyto-geographic view the Crvanj Mt. has a specific position (Lakusic, 1969; Čarni et al., 2009). It belongs to Moesian province of Eurosibirian-Boreal-American region. Northern and west side and feels a strong penetration of the Illyrian Provinces. The southern by this mountain range was under the influence of the Adriatic provinces with the highest peaks of the influence of high-Alpine-Dinaric province of High-Nordic region (Redžić and Dizdarevic, 1998).

MATERIALS AND METHODS

Evaluation forms of vegetation structure were carried out on the basis of phytocoenological and ecological studies of vegetation of meadows and pastures in the example Crvanj mountain. Started from the hypothesis that Crvanj mountain has the opposite position from the capital of other positions of the Dinaric mountains, and different environmental conditions. As a good indicator of overall needs and diversity of the natural vegetation, particularly vegetation of meadows and pastures, and wetlands.

Phytocoenological and ecological research of grassland and pasture vegetation in the mountainous and upland belt of Crvanj Mt. have been carried out over more seasons during 2000 to 2008.

This period were taken into consideration and the data obtained during 1983 to 1984 in order to have comparative analysis. Braun-Blanquet (1964) methodology was applied. In accordance with the principles of this methodology samples were taken (vegetation phytocoenological recordings) on the horizontal and vertical profile of the Crvanj Mt. In selected areas phytocoenological recordings (releves) were undertaken in different seasons at approximately the same area. Each recording includes phytocoenological qualitative-quantitative analysis of a given type of vegetation that includes inventorying plants and assess their abundance and coverage.

On each site were taken and samples of soil on the basis of which were done laboratory analysis and made their identification on the types. Altitude, slope and exposure of selected sites have been determined using by GPS and topographic maps at a scale of 1 : 50000.

In the field conditions were collected and plant material all registered plants later in laboratory conditions and stored properly herbarized and storaged in the Herbarium of the Center for Ecology and Natural Resources of the Faculty of Science University of Sarajevo (CEPRES HERB!).

Life forms and floral elements of plants are taken according to Oberdorfer (1983), and the ones of endemic taxa according to Hayek (1924-1933). Nomenclature of taxa is given according to Flora Europea (Tutin et al., 1964-1980), and nomenclature of plant communities according to Rodwell et al. (2002) and Redzic (2007a, 2000b). Plant community determination is brought in accordance to the International Code of Phytosociological Nomenclature (Weber et al., 2000).

Raining factors, as well as humidity and warmth character of climate are determined according to Gračanin (1950) ex Redžić et al. (1992-95).

RESULTS AND DISCUSSION

Syntaxonomical overview of phytocoenoses

Class: FESTUCO-BROMETEA Br.- Bl. et R. Tx. 1943
Order: BROMETALIA ERECTI (W. Koch 1926) Br.– Bl. 1936
Alliance*: Xerobromion* Br.-Bl. et Moor 1938 emend. Moravec in G
Holub et al. 1967 (= *Bromion erect*i W. Koch emend. Oberd. 1967; *Carici-Bromion* nom. nov. Redžić 1991)
Suballiance: *Fumano-Scabiosenion leucophyllae* Redžić 1991
Ass.: *Carici caryophyllei-Scabiosetum leucophyllae* Redžić et al. 1984 emend. Redžić hoc loco
Alliance: *Mesobromion erecti* Br-Bl. et Moor 1938 emend. Oberd.
1967 (= *Cirsio acauli-Bromion erecti* Redžić 1991 nomen nov.)
Suballiance : *Eu-Mesobromenion* Oberd. 1957 (= *Cirsio-Bromenion* Redžić nomen nov.)
Ass.:*Bromo-Plantaginetum mediae* Ht 1931
Ass.: *Bromo-Plantaginetum mediae « subalpinum »* Blečić et Lakušić 1976
Order : *Scorzoneretalia villosae* H-ić 1975 (= *Scorzonero-Chrysopogonetalia* H-ić et Ht (1956) 1958 p.p.)
Alliance : *Scorzonerion villosae* H-ić 1949
Ass.: *Danthonio-Scorzoneretum villosae* Ht et H-ić (1956) 1958
Alliance: *Satureion subspicatae* Ht 1962 (= *Chrysopogoni-Satureion* Ht et H-ić 1934 p.p.)
Ass.: *Saturejo-Edraianthetum* Ht 1942 s.lat.

Class: *Molinio-Arrhenatheretea* R. Tx. 1937 emend. 1970
Order: *Molinietalia coeruleae* W. Koch 1926
Alliance*: Molinion coeruleae* W. Koch 1926
Ass.: *Scillo litardieri-Molinietum coeruleae* Redžić ass. nova hoc loco
(Syn.: M*olinietum coeruleae* (Allorge 1922) W. Koch 1926 *illyricum*
K. Maly 1933 apud H-ić 1963)
Alliance: *Arrhenatherion elatioris* R. Tx. 1937
Ass.: *Arrhenatheretum elatioris* R. Tx. 1937 s. lat.
Alliance: *Pancicion* Lakušić 1966
Ass.: *Hypochoereto-Crepidetum conyzifoliae* Redžić 1991
Order: *Agrosti-Festucetalia rubrae* Puscaru et al. 1956
Alliance: *Festuco-Agrostion capillaris* Redžić 1991
Ass.: *Asphodelo-Agrostietum capillaris* Redžić ass. nova hoch loco

Class: *Scheuchzerio-Caricetea fuscae* (Nordhagen 1936) R. Tx. 1937
Order: *Caricetalia davallianae* Br.-Bl. 1949
Alliance: *Caricion davallianae* Br.-Bl. 1949
Ass.: *Eriophoro latifolii-Menyanthetum trifoliate* Redžić ass. nova hoc loco

Reviewing of the most certain phytocoenoses

Community *Carici caryophyllei-Scabiosetum leucophyllae* Redžić et al. 1984 emend. Redžić hoc loco [art. 3, 19]
Lectotypus: Releve 1, Table 3 (Redzic et al., 1984)

This community is wide spread on vertical profile of Crvanj Mt. finding optimal ecological conditions in the zone of oak and mountainous beech woods which belong to the alliances *Quercion petraeae-cerris* (Lakušić, 1976) Lakušić et B. Jovanović 1980 and *Fagion moesiacae* Blečić et Lakušić 1967). It covers carboniferous foundation with developed calcomelanosol and shallow or degraded calcocambisol, on terrain with warm aspect and 35 degrees slope.

In this area, association is characterized by occurrence of *Scabiosa leucophylla* f. *bipinnatisecta* K. Maly and f. *virescens* Murbeck, *Carex caryophyllea, Hippocrepis comosa* and *Euphorbia myrsinites*. The most important species from the sub alliance *Fumano-Scabiosenion* and alliance *Xerobromion erecti* are: *Plantago holosteum, Fumana procumbens, Petrorhagia saxifraga, Thymus striatus, Asperula purpurea, Teucrium montanum, Potentilla tommasiniana* and others (Table 2).

Among class and order arts the highest constancy level comes to *Plantago media, Thesium linophyllon, Veronica jacquinii, Bromus erectus, Linum austriacum, Leucanthemum vulgare* (Table 2).

This association is described on the territory of village Donji Malovani on vertical profile Kupres-Cincar (Redžić, 1984) in the zone of mountainous beech woods in western Bosnia. It has also been later recognized on other localities in Bosnia and Herzegovina (Redžić et al., 1985).

On shallow soils and to the wind exposed places, association *Carici-Scabiosetum* makes syndynamic connection to distinct variant of association *Edraiantho-Satureietum* Ht 1942 from the alliance *Satureion subspicatae* Ht 1962, especially in the zone of thermophilous oak woods. This connection is especially high lightened through the development stages of association *Potentillo tommasinianae-Scabiosetum leucophyllae* Redžić 1991. On deeper soil and mild terrain slopes it creates syndynamic connection with communities of supra-Mediterranean meadows, especially with *Danthonio-Scorzoneretum villosae* Ht et H-ić 1956. Towards higher spots and colder places *Carici-Scabiosetum leucophyllae* is slowly been replaced by *Bromo-Plantaginetum mediae*, and on even colder places by *Bromo-Plantaginetum "subalpinum"*.

Community *Scillo litardierei-Molinietum coeruleae* Redžić ass. nova hoc loco [art.2,7,15,18]
(Syn.: *Molinietum coeruleae* (Allorge 1922) W. Koch 1926 *illyricum* K. Maly 1933 apud. Horvatić 1963 p.p.)
(Nomenclature type: Reléve 1, Table 3).

Table 2. The floristic composition and ecological features of plant community *Carici-Scabiosetum leucophyllae* Redžić et al. 1984 emend. Redzic hoc loco.

Community	***Carici-Scabiosetum leucophyllae***							
Locality	CRVANJ Mt. Herzegovina, W. Balkan; N 43° and 43°30' and E 18° and 18°30'							
Altitude (m)	1100	1100	1080	1070	1050			
Aspect	S/SW	S/SW	S/SW	S/SE	S			
Slope (°)	15	35	20	20	30			
Geological foundation	Limestone							
Type of the soil	Calcomelanosls with Rendzines							
Sample size (m^2)	100							
Coverage (%)	90	90	90	95	95			
Height of panicles (cm)	25	36	35	40	40			
Height of rosettes (cm)	12	15	15	15	15			
Date	20.5. 2003	20.5. 2003	10.6. 2006	16.6. 2007	16.6. 2007			
Releve No.	1	2	3	4	5			
Number of species in releve	44	45	41	40	47			
						FREQUENCY	**FLORAL ELEMENTS**	**LIFE FORMS**
Floristic composition								
Characteristic species of the association :								
Scabiosa leucophylla Borbas	1.2	2.2	2.2	2.2	2.2	5	balc	Ch
Carex caryophylla Latourr	2.2	2.2	3.3	2.3	2.2	5	eurassubozean-smed(circ)	H
Hippocrepis comosa L.	2.2	2.2	1.2	1.2	2.2	5	smed(-subatl)	H
Euphorbia myrsinites L.	+	+.2	+.2	+.2	+.2	5	s. Eur	Ch
The species of the alliance *Xerobromion erecti* Br.-Bl.et Moor 1958								
Fumana procumbens (Dunal) Gren.et Gordon	+.2	+.2	+.2	1.2	+.2	5	smed(-med)	Ch
Plantago holosteum Scop.	2.2	1.1	1.1	1.1	1.2	5	s. et sc. eur	H
Leontodon crispus Vill.	+.1	1.1	1.1	1.1	1.1	5	s. et sc. eur	H
Thymus striatus Vahl.	+.2	1.2	2.2	2.2	1.2	5	balc-apen	Ch
Petroragia saxifraga (L.) Link	+.1	1.1	1.2	1.2	1.1	5	(o)smed	Ch
Potentilla heptaphylla L.	+.1	+.1	+.1	+.2	+.1	5	europkont(-gemasskont)	H
Eryngium amethystinum L.	+.1	+.1	+.1	+.1	+.1	5	balc-apen	H
Asperula purpurea (L.) Ehrend	1.2	+.2	1.2	1.2	1.2	5	balc	H
Festuca pseudovina Hackel ex Wiessb.	2.2	2.2	2.2	1.2	1.2	5	kont(-smed)	H

Table 2. Contd.

Teucrium montanum L.	2.2	1.2	1.2	1.2	1.2	5	smed(-med)	Ch
Sedum acre L.	+.2	+.2	1.2	1.2	1.2	5	(no-)eurasssubozean(-smed)	Ch
Galium corrudefolium Vll.	.	1.2	1.2	.	1.1	3	med	H
Elymus hispidus (Opiz) Melderis	1.2	.	1.2	.	1.2	3	(no-)euraskont(-smed)H	H
Hernaria incana Lam.	1.2	.	.	.	1.2	2	med-smed	H
Potentilla tommasiniana F.W Schultz	.	1.2	.	.	1.2	2	s.e.eur	H
Sedum sexangulare L.	.	.	+.2	.	+.2	2	gemasskont-smed	Ch
Dianthus corymbosus Sibith. Et Sm	+.2	.	.	.	+.2	2	balc	Ch
Minuartia rubra (Scop.)McNeill	.	+.1	.	.	+.1	2	s.eur	Ch
The species of the order *Brometalia erecti* (W. Koch 1926) Br.-Bl.1936 and class *Festuco-Brometea* Br-Bl.et R. Tx. 1943:								
Plantago media L.	2.2	2.2	2.2	2.2	2.2	5	euras(kont)-smed	H
Prunella laciniata L(L.)L.	1.1	1.2	1.1	1.1	1.1	5	smed	H
Centaurea scabiosa L.	+.2	1.1	1.1	1.2	+.1	5	eurassubozean-smed	H
Lotus corniculatus L..f.ciliatus Koch	1.2	1.2	1.2	1.2	1.2	5	eurassubozean-smed	H
Filipendula vulgaris Moench	+.1	1.1	+.1	+.1	+.1	5	euraskont-smed	H
Thesium linophyllon L.	+.1	+.1	+.1	+.1	1.1	5	europkont	G
Leucanthemum vulgare Lam.	1.1	1.1	1.1	1.1	1.1	5	eurassubozean	H
Linum austriacum L.	+.1	+.1	+.1	+.1	+.1	5	osmed	H
Veronica jacquini Baumg	+.1	1.1	+.1	+.1	1.1	5	gemasskont	Ch
Sanguisorba minor Scop.	+.1	1.1	1.1	1.1	1.1	5	smed	H
Trifolium montanum L.	+.1	+.1	+.1	+.2	+.1	5	gemasskont-smed	H
Bromus erectus Hudson	1.2	2.2	2.2	2.2	1.2	5	smed	H
Carlina acaulis L.	+.1	+.1	1.1	+.1	+.1	5	opralp	H
Brachipodium pinnatum (L.) Beauv.	+.2	1.2	1.2	1.2	+.2	5	euras(kont)	H,Ch
Asperula cynanchyca L.	+.1	+.1	.	1.1	1.1	4	smed	H
Hieracium pilosela L.	.	2.2	1.2	1.2	1.3	4	no-eurassubozean	H
Teucrium chamaedrys L.	.	+.2	+.2	.	+.2	3	smed-med	Ch
Heliantemum nummularium (L) Miller	.	+.2	.	+.2	1.2	3	smed	Ch
Taraxacum laevigatum (Wild.) DC.	1.1	.	.	+.1	+.1	3	smed	H
Scorzonera villosa Scop.	+.1	+.2	+.1	.	.	3	balc	H
Ononis spinosa L.	.	+.2	.	+.1	.	2	smed	(H(Ch)
Doricnum herbaceum Vill.	+.2	.	.	.	+.2	2	osmed-smed	Ch
Cerastium ligusticum Viv.	.	.	+.2	.	+.1	2	med	Ch

Table 2. Contd.

The other species:								
Primula columnae Ten.	+.1	+.1	1.1	+.1	+.1	5	s.eur	H
Thymus serpyllum L.	1.2	1.2	2.2	1.2	1.2	5	europkont	Ch
Ornitoghalum pyrenaicum L.	+.1	.	.	+.1	+.1	3	atl-smed	G
Polygala comosa Schkuhr	+.2	.	+.2	+.2	.	3	euraskont-smed	H
Gentiana utricolosa L.	+.1	+.1	.	.	.	2	(o)pralp	T
Lythospermum arvense L.	.	+.2	.	+.1	.	2	osmed(-gemaskont)	T
Helleborus odorus Waldst. et Kit.	+.1	+.2	.	.	.	2	balc	G(T(H)
Cirsium montanum (Walds. et Kit. Ex Willd.) Sprengel	.	+.1	.	,	.	2	balc	H
Salvia verticillata L.	.	+.2	.	.	.	1	gemasskont-osmed	H
Medicago falcata L.	+.2	.	.	.	.	1	euras(kont)-smed	H
Geum mole Vis. et Pančić	.	.	.+	.	.	1	balc-apen	H
Daucus carota L.	.	.	.	.+	.	1	eurassubozean-smed	H
Anthemis arvensis L.	+.1	.	.	.	.	1	eurassubozean-med	T
Convolvulus arvensis L.	.	.	.	.	+.2	1	med-smed-euras	G(H)

Purple moor grass association is developed around Uloško or Backo Lake, on eugley and swampy gley soils where it creates distinct belt. The characteristic species are: *Scilla litardierei*, *Dactylorhiza maculate* and *Carex brizoides*.

In this area association is being characterized by occurrence of other diagnostic species: *Hieracium pratense, Allium carinatum, Epipactis palustris, Molinia coerulea* and *Danthonia decumbens* (Table 3).

Through the comparative analysis of floristic composition between these stands and stand from other localities of this association (Maly, 1933; Riter-Studnička, 1954; Redžić, 1990), it has been detected higher similarity level with continental variants of the association, and furthermore with typical middle European variants of *Molinietum coeruleae* (Horvat, 1962; Ilijanić, 1973, 1979, Balatova-Tulačkova, 1985; Mucina, 1997; Rodwell et al., 2002; Havlova, 2006; Zelnik and Carni, 2008; Stancic, 2008; Lastrucci et al., 2009) than with association *Molinietum coeruleae Illyricum* originating from the karst fields (Riter-Studnička, 1954).

Analysed stands from the karst fields in Bosnia and Herzegovina (Livanjsko, Duvanjsko, Glamočko, Gatačko and Dabarsko karst field "polje") differ to significant extent from until now known Illyrian Molinietum communities. They have been differentiated through the occurrence of endemic Dinaric and Balkan arts, such as: *Succcisella petteri* (J. Kerner et Murbeck) G. Beck, *Scilla litardierei* Breistr., *Edraianthus dalmaticus* (A.DC.) A.DC., then *Iris sibirica, Sesleria uliginosa, Ranunculus auricomus* f. *crenatus*, *Serratula lycopifolia, Lathyrus pannonicus, Peucedanum pospichalii, Leucojum aestivum, Plantago altissima* and others that is characteristic for karst field's vegetation (Riter-Studnička, 1954). This is obviously distinct hygrophilous meadow community that is strongly affiliated with karst fields and from syntaxonomy point of view stands much closer to the alliance *Molinio-Hordeion secalini* H-ić 1934 order *Trifolio-Hordeetalia* H-ić 1934 than to the alliance *Molinion coeruleae* order *Molinietalia*. Due to maximal constancy of *Sesleria uliginosa* and its high phytocoenological and ecological diagnostic value in this region of Dinaric Alps, association of karst fields should be named *Seslerio uliginosi-Molinietum* and added to the alliance *Molinio-Hordeion secalini*. Typical Illyrian *Molinietum* communities encompass stands that are present on higher altitudes in SE Europe and that are

Table 3. The floristic composition and ecological features of plant community *Scillo litardierei-Molinietum coeruleae* Redzic ass. nova hoc loco.

Community	***Scillo litardierei-Molinietum coeruleae***										**FREQUENCY**	**FLORAL ELEMENTS**	**LIFE FORMS**
Locality	Ulosko lake - CRVANJ Mt. Herzegovina, W. Balkan - 43° and 43°30' and E 18° and 18°30'												
Altitude (m)	1060	1070	1070	1100	1070	1080	1100	1075	1085	1100			
Aspect	SE	SE	E	E	N	N	NE	NW	S	S			
Slope (°)	2	3	2	4	3	3	5	3	2	2			
Geological foundation	Silicates												
Type of the soil	Eugley												
Sample size (m^2)	100	100	100	100	100	100	100	100	100	100			
Coverage (%)	100	100	100	100	100	100	100	100	100	100			
Height of panicles (cm)	50	50	60	45	60	35	35	37	25	25			
Height of rosettes (cm)	10	10	20	15	15	15	15	15	15	15			
Date	23.6. 1987	23.6. 1987	15.6. 2000	15.6 2000	10.6 2002	10.6 2003	19.5. 2003	19.5. 2005	20.5 2005	20.5. 2005			
Releve No.	1	2	3	4	5	6	7	8	9	10			
Number of species in releve	32	31	33	36	38	27	32	27	28	29			
Floristic composition													
Characteristic species of the association :													
Scilla litardierei Breistr	2.2	1.2	1.2	+.1	+.2	2.2	2.2	1.2	2.2	2.2	10	din	G
Dactylorhiza maculata (L.)Soo	+.1	1.1	1.1	1.1	1.1	1.1	1.1	+.1	1.1	1.1	10	no-eurassubozean	G
Carex brizoides L.	+.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	+.2	+.2	10	gemasskont	H
The species of the alliance *Molinion coeruleae* W.Koch 1926 and order *Molinietalia* W.Koch 1926													
Molinia coerulea (L.) Moench	2.2	2.3	2.2	2.2	3.3	3.3	2.2	2.2	2.2	2.2	10	no-euras(subozean)	H
Hieracium pratense Tauschan	1.1	1.1	1.1	+.1	+.1	+.1	1.1	+.1	+.1	+.1	10	no-euraskont	H
Allium carinatum L.	+.1	1.1	1.1	1.1	+.1	1.1	+.1	1.1	+.1	+.1	10	osmed-pralp	G
Epipactis palustris (L.) Crantz	1.1	1.1	1.1	2.1	1.1	+.1	+.1	+.1	+.1	+.1	10	euras(subozean)-smed	G
Danthonia decumbens (L.) DC.	1.2	1.2	1.2	1.2	1.2	+.2	+.2	+.2	+.2	+.2	10	subatl(-smed)	H
Sanguisorba officinalis L.	1.1	1.2	+.2	.	.	.	1.2	1.2	1.2	+.2	7	euras(-smed),circ	H
Stachys officinalis (L.) Trevisan	.	.	1.2	+.2	1.2	.	.	1.2	+.2	+.2	6	eurassubozean-smed	H
Filipendula ulmaria (L) Maxim	1.3	.	.	.	1.2	2.2	2.3	+.2	.	1.2	6	no-euraskont	H

Table 3. Contd.

Lysimachia vulgaris L	.	1.3	1.2	1.2	.	.	.	1.2	1.2	1.2	6	(no-)euras-smed	H
Trifolium hybridum L.	.	+.2	+.2	.	+.2	.	+.2	.	+.2	.	5	alp	H
Juncus effusus L	.	.	.	+.2	.	1.2	+.2	+.2	.	.	4	euras(subozean)-circ	H
Succisa pratensis Mch.	+.2	.	.	1.2	+.2	.	.	.	.	.	3	eurassubozean-smed	
Caltha laeta Schott. Nyman et Kotschy	.	.	.	.	.	+.2	+.2	.	.	+.2	3	-(arkt-)no-euras,circ	H
Leontodon autumnalis L.	.	1.1	.	.	.	.	.	+.1			2	no-eurassubozean	H
Scirpus sylvaticus L.	.	.	1.2	.	.	.	.	.	+.2	.	2	(no-)eurassubozean, circ	G
Cirsium palustre (L.) Scop.	.	.	.	+.2	.	.	.	.	.	+.2	2	no-euras(subozean)	H
Ophioglossum vulgatus L.	+.1	.	.	.	.	.	+.1	.	.		2	euras(subozean),circ	H
Succisella inflexa (Kluk) G.Beck	.	.	.	.	+.2	.	.	.	+.1	.	2	gemaskont	H
Cirsium rivulare (Jacq.) All.	.	+.2	.	.	.	+.2	.	.	.	.	2	opralp-gemaskont	H
The species of the class *Molinio-Arrhenatheretea* R.Tx. 1937 emend.													
Potentilla erecta (L.) Rauschel	1.2	+.2	+.2	+.2	1.2	2.2	1.2	1.2	1.2	1.2	10	no-eurassubozean	H
Prunella vulgaris L.	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	+.2	+.2	10	no-euras	H
Ranunculus acris L.	+.1	1.1	+.1	+.1	1.1	2.2	2.2	1.2	1.2	1.2	10	no-eurassubozean	H
Centaurea jacea L.	1.1	1.1	1.1	+.2	+.2	1.1	1.1	1.1	+.2	+.2	10	eurassubozean-smed	H
Trifolium pratense L.	1.2	+.2	1.2	1.2	+.2	.	.	+.2	+.2	+.2	10	eurassubozean(-smed)	H
Holcus lanatus L.	1.1	1.1	1.2	1.2	+.2	+.2	+.2	.	+.2	+.2	9	subatl-smed	H
Leucanthemum vulgare Lam.	2.1	1.1	1.1	1.1	1.1	1.1	1.1	.	.	+.1	9	eurassubozean(-smed)	H
Cynosusrus cristatus L.	1.1	+.1	1.1	1.1	1.1	+.2	+.2	+.2	.	.	8	subatl(-smed)	H
Rhinathus minor L.	+.1	+.1	+.1	+.1	+.1	+.1	+.2	+.1	.	.	8	no-eurassubozean,circ	H
Anthoxanthum odoratum L.	+.1	1.1	1.1	+.1	+.1	.	.	+.2	+.2	+.2	8	no(-eurassubozean)	H
Plantago lanceolata L.	+.1	1.1	1.1	1.1	+.2	+.1	1.1	.	.	+.2	8	eurassubozean(-smed)	H
Deschampsia caespitosa (L.) Beauv.	.	.	1.2	1.2	+.2	.	+.2	.	+.2	+.2	6	no-euras,circ	H
Trifolium hybridum L.	.	.	1.2	1.2	+.2	.	+.2	+.2	.	.	5	gemasskont	H
Taraxacum palustre (Lyons) Symons	.	.	+.1	+.1	+.1	.	+.1	+.1	.	.	5	euras(subozan)-med	H
Euphrasia stricta Wolff ex J.F.Lohm	+.1	+.1	+.1	+.1	+.1	.	.	.	.	.	5	(eurassubozean)subatl(-smed)	T
Briza media L.	+.2	+.1	+.2	1.1	1.2	.	.	.	.	.	5	eurassubozean(-smed)	H
Lychnis flos-cuculi L.	.	.	.	+.1	1.1	1.1	.	.	.	+.1	4	eurassusbozean	H

Table 3. Contd.

Rumex acetosa L.	+.1	.	.	.	+.1	.	+.1	.	+.1	.	4	no-euras,circ	H
Stellaria graminea L.	1.1	+.1	.	.	.	.	.	+.2	.	.	3	no-eurassubozean	H
Colchicum autumnale L.	.	.	.	+.1	1.1	.	.	.	.	+.1	3	subatl.smed	G
Vicia cracca L.	.	.	+.2	.	.	+.1	.	.	.	.	2	no-euras	H
Festuca rubra L.	.	.	.	+.2	.	.	.	.	+.2	.	2	no(subozean)	H
Agrostis capillaris L.	.	.	.	.	+.2	.	+.2	.	.	.	2	ozean-temp	H
The species of the class *Phragmitetea* R. Tx. et Prsg. 1942:													
Phragmites australis (Cav.) Trin et Steudel	2.1	1.1	1.1	+.1	1.1	+.1	1.1	+.2	1.2	+.2	10	no-euras-smed	W,G
Mentha aquatica L.	+.2	+.2	1.1	+.2	+.2	+.2	+.1	+.2	.	+.2	9	euras-smed(-med)	H,W
Lycopus europaeus L.	+.1	+.2	+.1	+.1	+.2	+.2	+.2	.	+.2	.	8	euras-smed(-med)	H,W
Chaerophyllum bulbosum L.	.	.	.	+.2	+.2	.	.	.	+.2	.	3	gemasskont	H,T
Other species:													
Trifolium montanum L.	+.2	+.1	.	.	.	+.2	+.2	.	.	.	4	gemasskont-smed	H
Leontodon hispidus L.	+.1	.	.	.	+.2	.	.	.	+.2	+.1	4	eurassubozean-smed	H

syngeneticaly connected to the vegetation of classes *Scheuchzerio-Caricetea fuscae* and *Oxyccoco-Sphagnetea*. In order to make clear, ecologic, floristic, horologic, syntaxonomic and syngenetic approach to the issue of Illyrian *Molinietum* communities in relationship to the similar vegetation types; it is necessary first to conduct more detailed comparative phytocoenological research.

The community *Asphodelo-Agrostietum capillaris* Redžić ass. nova hoc loco [art.2,7,15,18] (Nomenclature type: Reléve 1, Table 4).

This association is wider present on the territory around Ulosko or Backo lake, on marl and limestone in the series with hornstone and luvisol, on southern and south-eastern aspect and slopes up to 10 degrees.

Association is being characterized and differentiated from other closely related communities. The characteristic species are: *Asphodelus albus*, *Rhinanthus rumelicus* subsp. w*agneri* and *Scorzonera rosea*. Diagnostic values have also those species: *Lathyrus latifolius* and *Moenchia mantica.* From the alliance *Festuco-Agrostion capillaris* significant are *Agrostis capillaris (A. tenuis, A. vulgaris), Phleum pratense, Hieracium pratense, Centaurea jacea* s. str., *Ranunculus bulbosus, Euphrasia rostkoviana* and some others, where as from order *Agrosti-Festucetalia* and class *Molinio-Arrhenatheretea high* indicator value have got *Cynosurus cristatus, Knautia arvensis, Muscari comosum, Colchicum autumnale, Anthoxanthum odoratum, Campanula patula* and others (Table 4).

Association *Asphodelo-Agrostietum* is in terms of its ecology and floristic composition clearly differentiated from affine association *Festuco-Agrostetum* Ht (1951) 1962 emend. Trinajstić, 1972 (Horvat, 1962; Horvat et al., 1974; Trinajstić, 1972, 2008; Redžić and Lakušić, 1991; Lakušić et al., 1982 Redžić, 1990, Stancic 2005), which is mainly acidophilus and indicated by species belonging to the Eurasian and north-eastern Eurasian floral element. Studied association is

Table 4. The floristic composition and ecological features of plant community *Asphodelo-Agrostietum capillaris* Redzic ass. nova hoc loco.

Community	***Asphodelo-Agrostietum capillaris***													
Locality	CRVANJ Mt. Herzegovina, W. Balkan; N 43° and 43°30' and E 18° and 18°30'													
Altitude (m)	1150	1200	1220	1230	1100	1120	1250	1100	1300	1350	1350			
Aspect	S/SW	S/SW	S-SW	S-SW	S	S	SE	SE	S	S	SE			
Slope (°)	15	35	18	15	30	5	6	10	5	5	10			
Geological foundation	Limestone with silicates													
Type of the soil	Kalcokambisols with luvisols													
Sample size (m^2)	100	100	100	100	100	100	100	100	100	100	100			
Coverage (%)	90	90	90	95	95	100	100	100	100	100	100			
Height of panicles (cm)	15	18	20	22	24	26	30	30	25	20	25			
Height of rosettes (cm)	40	40	45	45	48	50	50	45	55	60	55			
Date	16.6. 2000	16.6 2000	25.7 2003	25.7 2003	25.7. 2006	26.7. 2006	26.7. 2006	30.6. 2007	30.6. 2007	1.8. 2007	1.8. 2007			
Releve No.	1	2	3	4	5	6	7	8	9	10	11			
Number of species in releve	30	31	26	25	27	35	34	36	37	34	31			
Floristic composition														
Characteristic species of the association :														
Asphodelus albus Miller	1.1	1.1	+.2	+.2	+.2	+.2	+.2	1.2	+.2	+.2	+.2	10	s.eur	G
Scorzonera rosea Waldst.et Kit.	1.1	1.1	+.2	1.2	1.2	1.2	1.1	+.2	+.2	1.2	+.2	10	balc	H
Rhinathus rumelicus Velen. subsp. wagneri (Degen) Bjelčić	1.1	1.1	1.1	1.1	+.1	1.1	1.1	+.1	1.1	1.1	+.1	10	balc	T
The species of the alliance: *Festuco-Agrostion capillaris* Redžić 1991														
Lathyrus latifolius L.	1.1	1.2	1.2	1.2	1.2	1.1	1.1	1.2	1.2	1.1	+.2	10	smed	H
Moenchia mantica L.(L.)Bartl.	+.1	1.1	1.1	2.1	2.1	2.1	2.1	1.1	2.1	2.1	1.1	10	s.e.eur.	T
Agrostis capillaris L.	2.2	3.3	2.3	2.3	2.2	1.2	2.2	2.3	2.2	2.3	2.2	10	no-eurassubozean	H
Phleum pratense L.	1.2	1.2	+.2	+.2	+.2	+.2	+.1	+.2	1.1	+.1	1.1	10	no-euras	H
Hieracium pratense L.	+.1	+.1	+.1	+.1	1.1	+.1	1.1	1.1	1.1	+.1	1.1	10	no-euraskont	H

FREQUENCY | **FLORAL ELEMENTS** | **LIFE FORMS**

Table 4. Contd.

Centaurea jacea L.	1.2	1.2	1.2	1.1	1.1	1.2	2.2	2.3	1.1	1.1	1.1	10	eurassubozean-smed	H
Leontodon hispidus L.	1.1	1.1	+.2	+.2	1.2	1.1	1.1	1.1	1.1	+.1	1.1	10	eurassubozean-smed	H
Ranunculus bulbosus L.	+.1	+.1	1.1	1.1	1.1	1.1	+.1	1.1	1.1	1.1	1.1	10	smed-subatl	H(G)
Plantago lanceolata L.	1.1	1.1	+.1	+.1	+.1	+.1	+.1	+.1	+.1	+.1	+.1	10	eurassubozean	H
Festuca nigrescens Lam.	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	10	no(subozean)	H
Polygala vulgaris L.	+.2	+.2	.	.	.	+.2	+.2	+.2	+.1	+.1	1.1	7	subatl(-smed)	H(Ch)
Galim verum L.	.	+.2	.	.	.	+.2	1.2	1.2	1.2	+.2	+.2	6	euras-smed	H
Euphrasia rostkoviana Hayne	.	.	+.1	.	.	+.1	1.1	.	.	1.1	.	4	euras(kont)	T
The species of the order and class: *Agrosti-Festucetalia rubrae* Puscaru et al. 1956; *Molinio-Arrhenatheretea* R. Tx. 1937 emend 1970: *Molinio-Arrhenatheretea* R.Tx. 1937 emmend 1979														
Cynosusrus cristatus L.	1.1	+.1	+.1	1.1	+.1	1.1	1.1	1.1	1.1	1.1	+.1	10	subatl(-smed)	H
Knautia arvensis (L.) Coulter	+.1	1.1	1.1	+.1	+.1	+.1	1.1	1.1	1.1	+.1	+.1	10	(no-) eurassubozean	H
Achillea millefolium L.	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.1	+.1	1.1	10	no-eurassubozean	H(Ch)
Colchicum autumnale L.	+.1	1.1	1.1	1.1	1.1	+.1	+.1	+.1	1.1	1.1	+.1	10	subatl-smed	G
Vicia cracca L.	+.2	1.2	1.2	1.2	+-2	1.2	1.3	1.2	1.2	1.2	1.1	10	no-euras	H
Muscari comosum (L) Miller	+.1	.	.	+.1	.	+.1	+.1	+.1	+.1	+.1	+.1	8	med-smed	G
Tragopogon pratensis L.	.	1.1	1.1	+.1	+.1	+.1	.	+.1	+.1	.	+.1	8	subatl	H
Anthoxanthum odoratum L.	+.1	1.1	+.1	.	.	1.1	1.1	1.1	.	1.1	.	7	no(-eurassubozean)	H
Campanula patula L.	.	+.1	.	.	.	+.2	+.1	+.2	.	+.1	+.1	6	euras(-kont)(smed)	H
*Hypoheris r*adicata L.	.	.	.	.	.	+.1	+.1	+.2	.	+.1	+.1	5	subatl (-smed)	H
Trifolium repens L.	.	.	.	.	.	+.1	.	+.1	.	.	+.2	3	eurassubozean(-smed)	H(Ch)
Veronica serpyllifolia L.	.	.	.	.	.	+.1	.	.	.	+.2	.	2	no-eurassubozean	H
Carum carvi L.	.	.	.	.	.	+.1	.	.	.	+.1	.	2	no-pralp	H
Dactyllis glomerata L.	.	.	.	.	.	.	.	+.2	.	+.1	.	2	eurassubozean-smed	H
Poa pratensis L.	+.2	.	.	.	.	.	.	.	.	2	.	2	euras(kont) (-smed)	H,G
Trifolium pratense L.	.	.	.	.	.	.	.	+.1	.	.	+.2	2	eurassubozean(-smed)	H
The species of the order *Brometalia erecti*														

Table 4. Contd.

(W. KocH 1926) Br.-Bl.1936 and *Festuco-Brometea* Br-Bl.Et R. Tx. 1943														
Plantago media L.	1.2	+.2	+.2	.	1.2	1.2	+.2	+.2	1.2	+.1	.	8	euras(kont)-smed	H
Prunella laciniata (L.) L.	.	1.2	.	.	1.1	1.2	1.1	1.1	+.2	+.1	+.1	8	smed	H
Centaurea scabiosa L.	.	1.1	.	.	+.1	.	.	+.1	+.1	.	.	4	eurassubozean-smed	H
Lotus cornitulatus L.f.ciliatus Koch	.	1.2	.	.	1.2	.	+.1	.	+.2	.	.	4	eurassubozean-smed	H
Filipendula vulgaris Moench	+.1	.	.	.	.	+.1	.	+.1	1.1	+.1	.	5	euraskont-smed	H
Thesium linophyllon L.	+.1	+.1	.	.	1.1	.	.	.	.	.	.	3	europkont	G
Other species:														
Sanguisorba muricata (Spach) Gremli	1.1	1.1	+.1	+.1	+.1	+.1	+.1	+.1	1.1	+.1	+.1	10	med(-kont)	H
Thalictrum flavum L.	+.1	1.1	.	1.1	+.1	.	+.1	.	+.1	+.1	+.1	8	(no-)euras	H
Equisetum arvense L.	+.1	.	.	.	+.1	1.1	+.1	.	+.1	.	+.1	6	no-eruras,circ	G
Ornitoghalum pyrenaicum L.	.	.	+.1	+.1	.	.	.	+.1	1.1	+.1	.	5	atl-smed	G
Salvia verticilata L.	.	.	+.2	+.2	.	+.1	.	.	+.2	+.2	.	5	gemasskont-osmed	H
Medicago falcata L.	+.2	.	.	.	.	+.1	.	.	+.2	.	+.2	4	euras(kont)-smed	H
Daucus carota L.	.	+.1	.	.	.	.	.	+.1	+.1	.	.	3	eurassubozean-smed	H
Anthemis arvensis L.	.	.	+.1	.	.	.	+.1	.	+.1	.	.	3	eurassubozean-med	T
Convolvulus arvensis L.	.	.	.	+.2	.	.	+.1	.	+.1	.	.	3	med-smed-euras	G(H)
Campanula rapuncoloides L.	.	.	.	.	.	.	+.1	+.1	+.1	.	.	3	gemasskont-smed	H
Leucanthemum vulgare Lam.	+.1	.	.	.	1.1	.	.	.	.	.	.	2	eurassubozean	H

more neutrophilous to basophiles, characterized by occurrence of arts that have Balkan, south-European and supra-Mediterranean distribution. Besides, this association is also marked by its specific syngenesis. On higher located spots and more neutrophilous soils it makes syndinamic connection with the communities of endemic south-eastern alliance *Pančićion* Lakušić 1966, especially through the development stages of the association *Hypochoereto-Crepidetum conizifoliae* Redžić 1991, on nutrient rich soils along with the association *Arrhenatheretum elatioris* s. lat. *Festuco-Agrostetum* (Gazi-Baskova and Šegulja, 1978, Redžić, 1984, 2000).

The community *Eriophoro latifolii-Menyanthetum trifoliate* Redžić ass. nova hoc loco [art.2,7,15,18] (Nomenclature type: Reléve 3, Table 5).

Thanks to its floristic and ecologic attributes, this association belongs to the blanket bog vegetation. It is being developed in form of narrow belt around Uloško or Backo Lake, on middle deep planohistosol that isn't being formed by participation of *Sphagnum* Ehrh species.

Association is being characterized by occurrence of arctic and northeast-Eurasian species that are considered to be relict in the area. Characteristic species are: *Menyanthes trifoliata* (opt.), *Eriophorum latifolium* and *Cirsium palustre*. Significant species to this alliance, order

Table 5. The floristic composition and ecological features of plant community *Eriophoro-Menyanthetum trifoliati* Redzic ass. nova hoc loco.

Community	***Eriophoro-Menyanthetum trifoliati***												
Locality	CRVANJ MT. (Herzegovina, W. Balkan); N 43° and 43°30' and E 18° and 18°30												
Aspect	SE		N		NE	NW	SE		NW				
Slope (°)	3						2		3				
Geological foundation	Silicates												
Type of soil	Plano-histosols												
Size of releve (m^2)	100												
Coverage (%)	100												
Height of panicles (cm)	45		50		45		50		45		35		
Height of rosettes (cm)	20		15		20		15		20				
Date	23.6.	23.6.	15.6.	15.6	10.6	10.6	19.5.	19.5.	20.5	20.5.			
	1987		2000		2002		2003		2007				
Releve No.	1	2	3	4	5	6	7	8	9	10			
Number of species in releve	23	22	24	23	23	23	19	22	21	25			
Floristic composition:													
Characteristic species of the association:													
Menyanthes trifoliata L.	3.3	4.4	4.4	4.4	3.3	4.4	3.3	3.3	2.3	3.3	10	arct-no, circ	W
Eryophorum latifolium Hoppe	1.1	1.1	2.1	1.1	1.1	1.1	1.1	2.1	2.1	2.1	10	no-euras(subozean)	H
Cirsium palustre (L.)Scop.	+.1	+.1	+.1	1.1	+.1	1.1	1.1	+.1	+.1	1.1	10	no-euras(subozean)	H
The species of the alliance: *Caricion davallianae* and order: *Caricetalia davallianae*													
Equisetum palustre L.	1.1	1.1	1.1	1.1	1.1	1.1	+.1	+.1	1.1	1.1	10	no-euras, circ	G
Eleocharis palustris (L.) Roemer et Schultes	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	10	no-euras, circ	W
Carex gracilis Curtis	2.2	1.2	1.2	+.2	+.2	1.2	1.2	1.2	1.2	1.2	10	no-euras,circ	G(H,W)
Philonotis fontana (L.) Brid.	2.2	2.3	3.3	1.3	2.2	2.2	2.3	3.3	3.3	3.3	10	cicumbor	Ch
Veronica scutellata L.	+.1	1.1	1.1	+.1	+.1	+.1	+.1	+.1	1.1	1.1	10	(no-)s batl, circ	H
Juncus lamprocarpus Echrh. Ex Hoffm.	.	.	1.2	1.2	1.2	+.2	+.2	+.2	+.2	+.2	8	euras(subozean)-smed	H
Galium palustre L.	+.1	+.1	1.1	1.1	1.1	1.1	.	.	+.1	+.1	8	no-eurassubozean	H
Dactylorhiza maculata (L.) Soo	+.1	+.1	1.1	.	.	+.1	.	+.1	.	1.1	6	no-eurassubozean	G
Carex brizoides L.	+.2	.	+.2	.	.	.	1.2	.	.	+.2	5	gemasskont	H

FREQUENCY | **FLORAL ELEMENTS** | **LIFE FORMS**

Table 5. Contd.

Carex nigra (L.) Reichard	.	+.2	.	+.2	+.2	.	.	.	.	.	3	eurassubozean?	H
The species of the class:													
Scheuzherio-Caricetea fuscae													
and *Phragmitetea*													
Phragmites australis (Cav.) Trin et Steudel	2.1	1.1	1.1	+.1	1.1	+.1	1.1	+.2	1.2	+.2	10	no-euras-smed	W,G
Mentha aquatica L.	+.2	+.2	1.1	+.2	+.2	+.2	+.1	+.2	.	+.2	9	euras-smed(-med)	H,W
Drepanocladus aduncus (Hedw.) Moenkm.	1.2	2.2	1.2	.	.	1.2	1.2	+.2	+.2	1.2	8	circumbor	Ch
Lycopus europaeus L.	1.1	1.2	1.1	1.1	1.2	1.2	.	+.2	1.2	.	8	euras-smed(-med)	H,W
Alisma plantago-aquatica L.	1.1	1.2	.	.	1.2	1.2	.	.	+.1	+.2	6	euras-smed	W
Chaerophyllum bulbosum L.	.	.	.	+.2	+.2	.	.	.	+.2	.	3	gemasskont	H,T
Cirsium rivulare (Jacq.) All.	.	+.2	.	.	.	+.2	.	.	.	.	2	opralp-gemaskont	H
Ranunculus flammula L.	.	.	.	.	.	.	+.2	+.2	.	.	2	eurassubozean(-smed)	H(W)
Iris pseudacorus L.	.	.	.	.	.	.	.	.	.	+.2	1	euras(subozean)-smed	W(H)
Myosotis caespitosa K.F. Schultz	.	.	+.2	.	.	.	.	.	.	.	1	no-euras,circ	H
The species of the class													
Molinio-Arrhenatheretea R.Tx. 1937 emend.													
Deschampsia caespitosa (L.) Beauv.	+.2	.	+.2	1.2	1.2	1.2	+.2	+.2	+.2	+.2	9	no-euras,circ	H
Potentilla erecta (L.) Rauschel	1.2	+.2	+.2	+.2	+.2	+.2	.	.	+.2	+.2	8	no-eurassubozean	H
Prunella vulgaris L.	+.2	+.1	+.2	+.1	.	.	.	1.2	+.2	+.2	7	no-euras	H
Ranunculus acris L.	+.1	+.1	+.1	.	1.1	.	.	+.2	+.2	+.2	7	no-eurassubozean	H
Trifolium hybridum L.	.	.	+.1	+.1	+.1	+.2	+.2	+.2	+.2	.	7	gemasskont	H
Taraxacum palustre (Lyons) Symons	+.1	+.1	1.1	+.1	+.1	+.1	+.1	.	.	.	7	euras(subozean)-med	H

Table 5. Contd.

Plantago lanceolata L.	.	.	.	+.1	+.1	+.1	+.2	.	.	+.2	5	eurassubozean(-smed)	H
Centaurea jacea L. ssp. pannonica (Heuff.) Hayek	+.2	.	.	.	.	.	.	+.2	+.2	+.2	4	gemaesskont(-osmed)	H
Lychnis flos-cuculi L.	.	+.1	.	+.1	.	.	.	.	.	+.1	3	eurassusbozean	H
Colchicum autumnale L.	+.1	.	.	+.1	.	.	.	.	.	+.1	3	subatl-smed	G
Succisa pratensis Mch.	.	.	.	.	+.2	.	.	+.2	.	.	2	eurassubozean-smed	H
Filipendula ulmaria (L) Maxim.	.	.	+.2	.	.	+.2	.	.	.	.	2	no-euraskont	H
Plantago altissima L.	.	.	.	.	.	.	+.2	.	.	.	1	gemaskont-osmed	H
Festuca arundinacea Schreb.	.	.	.	.	.	.	.	+.2	.	.	1	subatl(-smed)	H

and class are Equisetum palustre, Philonotis fontana, Veronica scutelata, Galium palustre, Deschampsia caespitosa, Trifolium hybridum, Phragmites australis, Mentha aquatica and others (Table 5).

From phyto-geographical point of view, finding place of *Menyanthes trifoliata* in the area of Crvanj Mt. is highly valuable one. It was discovered here by K. Maly (in Beck-Mannagetta et al., 1974: 50). This is one of the most southern finding places of the species in Bosnia and Herzegovina. On the territory of SE Dinaric Alps it reaches Mt. Lovćen (Pejović, Rohlena in Rohlena, 1942: 321). According to Hayek (1927: 426) it occurs in Macedonia and Albania, too. On Dinaric Alps populations of *Menyanthes trifoliata* participate in composition of few plant communities - *Rhynchosporetum albae* (Horvat, 1939, Trinajstić, 1973), *Menyanthi-Sphagnetum* (Lakušić et al. 1967-1970), *Scirpetum silvatici* and others. Around Kotlaničko lake on Mt. Zelengora and on Mt. Treskavica is developed endemic and relict association *Comaro-Menyanthetum* Lakušić et al., 1969 *Sphagnion fusci*, order *Sphagnetalia fusci* (Lakušić et al., 1978).

Studied *Eriophoro-Menyanthetum* association belongs to the alliance *Caricion davallianae*, order *Caricetalia davallianae*.

There are obviously two groups of *Menyanthes trifoliata* populations that are clearly ecological differentiated – acidophilus in the framework of class *Oxyccoco-Sphagnetea* and basophiles within the class *Scheuchzerio-Caricetea*. This rule has been recorded on the territory of Dinaric Alps and in south-eastern Europe, but also broader on the territory of middle and northern Europe (Ellenberg, 1986; Nilsen and Moen, 2009), and northern Asia (Korotkov et al., 1991; Han and Kim, 2006).

Floristic richness of community – biocenological diversity

Floristic richness is a good indicator of biocenologic diversity of plant communities which plays an important role in the processes of conservation *in situ* conditions (Redzic et al., 2010).

The investigated communities regarding this parameter are mediocre floristic richness (rating of 3) (Figure 2). However, their composition is quite stable. Relic communities *Eriophoro-Mentyanthetum trifoli*atae with a rating of 4 (relatively poor species). This indicates that develops in the glacial-relic habitat that is limited for many species from neighbouring habitats.

Analysis of floral elements

Species that have been detected on studied grasslands and pastures, in terms of belonging to the certain floral element, are split into 16 categories (Figure 3 to 6).

In the composition of *Carici-Scabiosetum* (Figure 3) occurs significant number of species that posse Balkan and southeast European distribution (26%) which makes them diverse from affine communities with middle European distribution (Maccherini et al., 2000; Bruun and Ejrnaes, 2000; Biondi et al., 2005; Geven et al., 2009). This is also supported by high representation of species that have sub-Mediterranean (16%) and Mediterranean (7%)

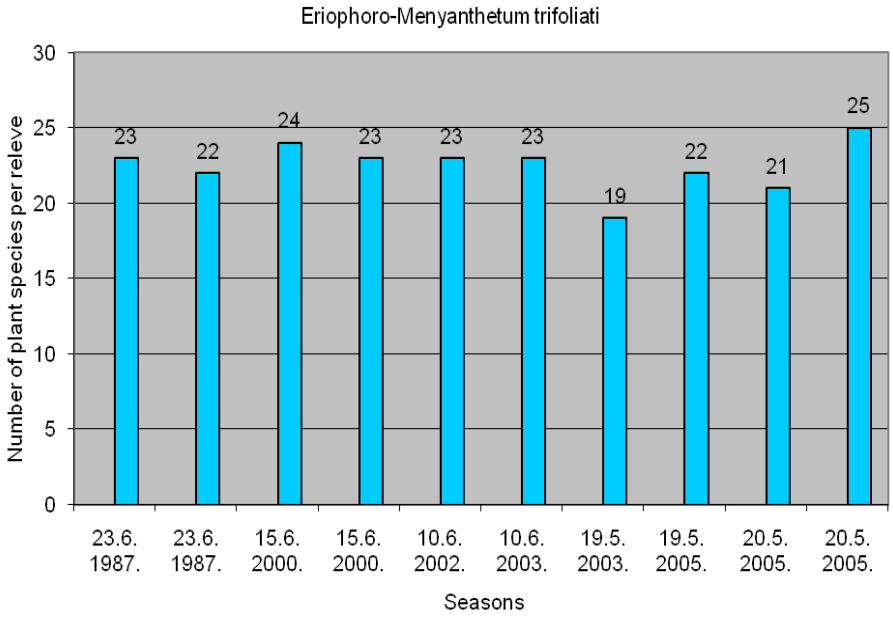

Figure 2. Floristic richness of investigated plant communities.

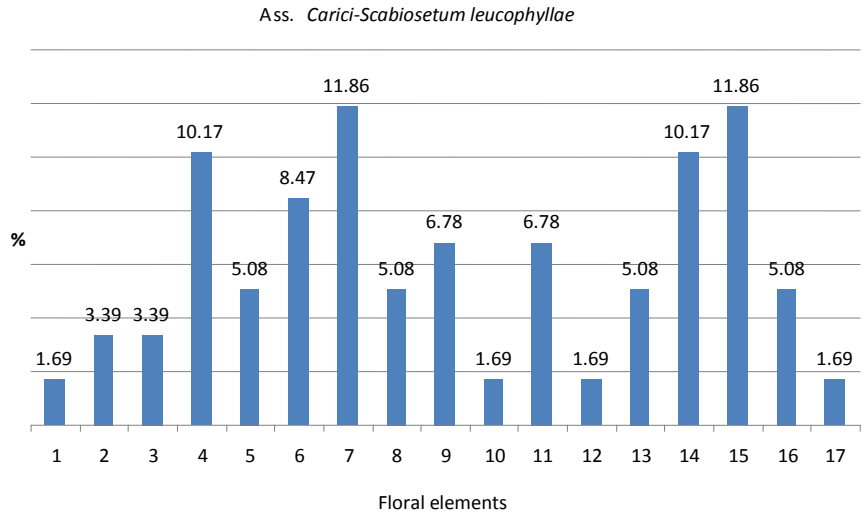

Figure 3. Spectrum of floral elements of *Carici-Scabiosetum leucophyllae* (Legend: 1. NE-Euras-continental 2. E-sub-Alpine 3. Atlantic-Sub-mediterranean 4. Balkans 5. Balkan-Apenine 6. Euras-continental 7. Euras-Suboceanic 8. Euro-continental 9. Continental 10. Continetal-sub-Mediterranean 11. Mediterranean 12. NE- Euras-Suboceanic 13. E-sub-Mediterranean 14. SE- European 15.sub-Mediterranean 16. Sub-Mediterranean-Mediterranean 17. Sub-Mediterranean-sub-Atlantic).

distribution. In same time there are more than 5% of subalpine species that differentiated this community from the typical *Bromion* communities (Horvat et al., 1974; Redzic, 1999, 2003).

The community of *Asphodelo-Agrostietum* and wider spread *Festuco-Agrostetum* community, as well as some other communities from the alliance *Festuco-Agrostion*, are being affined by populations of species that belong to northeast-Eurasian, euroasia-subocean and Eurasian floral element (44%). This community characterised by more species that bellong to Balkans, SE- European and sub-Mediterranean floral elements (16%) in relate to floristically similar other communities (Redžić and Lakušić, 1991; Redzic, 2007a; Trinajstic, 2008). More

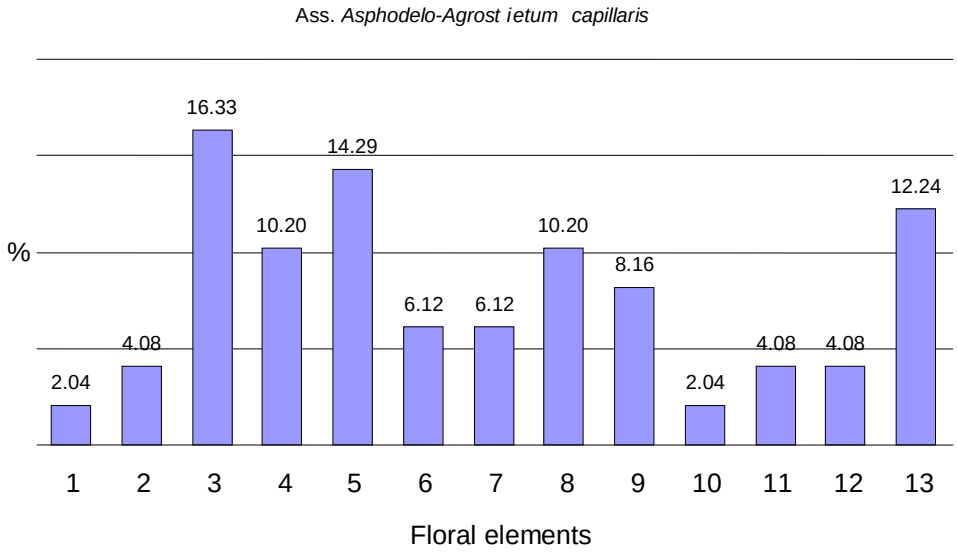

Figure 4. Spectrum of floral elements of *Asphodelo-Agrostietum capillaris* (Legend: 1. Atlantic-sub-Mediterranean 2. Balkans 3. Euras-continental 4. Euras-sub-Oceanic 5. Euras-sub-Oceanic-sub-Mediterranean 6. Continental 7. Mediterranean 8. NE- Euras 9. NE Euras-Suboceanic 10. NE- sub-Alpine 11.SE European 12. Sub-Mediterranean 13. Sub-Atlantics).

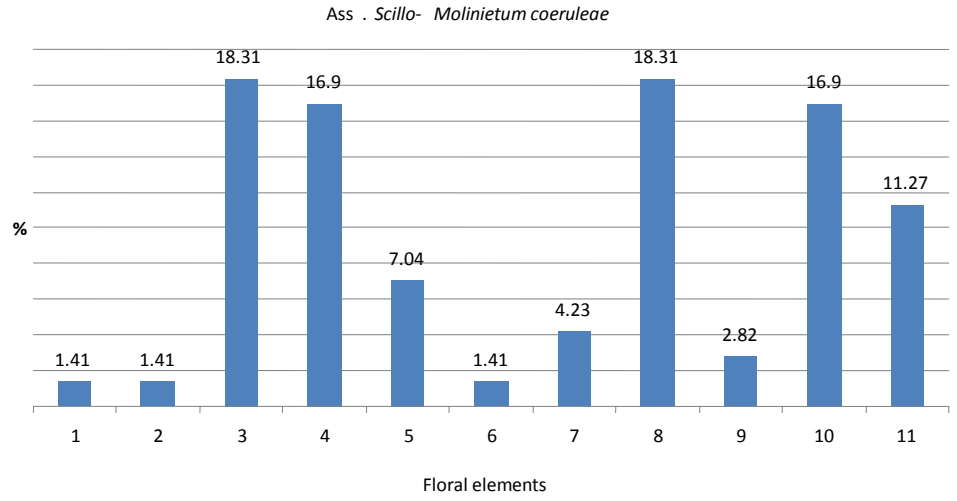

Figure 5. Spectrum of floral elements of *Scillo-Molinietum coeruleae* (Legend: 1. Alpines 2. Dinaric 3. Euroasian 4. Euras-Suboceanic 5. Continental 6. Mediterranean-sub-Mediterranean 7. NE- Euras-sub-Oceanic 8. NE-Euras 9. NE-continental 10. NE- Euras-sub-Oceanic 11. Sub-Atlantics).

detailed spectre of floral elements of this community is presented in Figure 4.

Association of *Scillo-Molinietum coeruleae* differ in this aspect from middle European *Molinietum coeruleae* association (Ellenberg, 1986; Havlova, 2006; Zelnik and Carni, 2008). It comprises 5% Dinaric 18% sub-Mediterranean and 5% Mediterranean floral elements (Figure 5).

Relict association *Eriophoro-Menyanthetum* is being dominated by species that belong to northeast-Eurasian floral element (52%) (Figure 6) which illustrates its floristic-genetical linkage to the bog communities of boreal zone (Nilsen and Moen, 2009).

Analysis of life forms

Spectrum of life forms is a very good bio indicator climatic

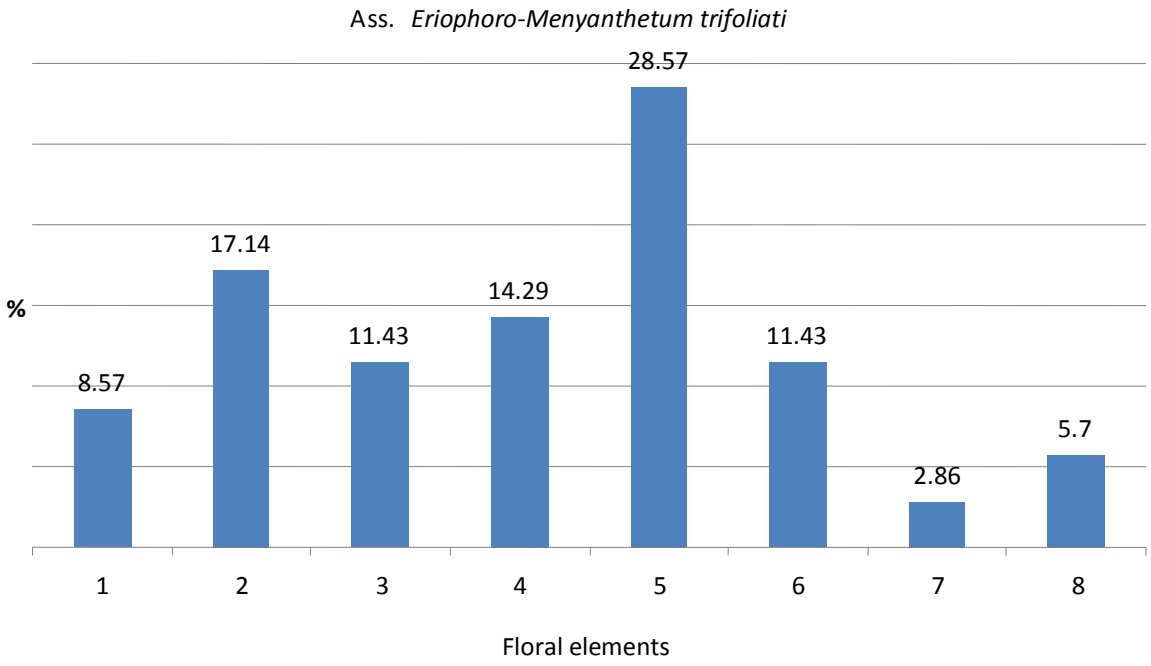

Figure 6. Spectrum of floral elements of *Eriophoro-Menianthetum trifoliati* (Legend: 1.Circum-Boreal 2. Euras-sub-Mediterranean 3. Euras-sub-Ozeanic 5. Continental 5. NE-Euras 6. NE-Euras-sub-ozeanic 7. E-sub-Alpine-Continental 8. Sub-Atlantics).

conditions in which vegetation develops (Horvat et al., 1974; Ellenberg, 1986; Bulic et al., 2008). In the researched area most communities are hemicryptophitic and geophitic, and only community Carici-Scabiosetum leucophyllae is hemicryptophitic and chamaephitic character (Figure 7a-d).

Community *Carici-Scabiosetum* that belongs to thermophilous grasslands and pastures is dominated by hemicryptophytes and chamaephytes (Fig. 7a) which indicates dry habitats and arid climate. Life forms spectrum of communities *Asphodello-Agrosteteum* and *Molinietum coeruleae* indicates more humid eco climate which is confirmed by significant abundance of geophytes (Figure 7b-c). Community *Eriophoro-Menyanthetum* is dominated by hemicryptophytes and hydrophytes (Figure 7-d), because this is swamp community that develops on basophiles peat.

Conclusion

Grassland and pasture vegetation of Crvanj Mt. is being characterized by high level of both biological and ecological diversity. On carbonate type of soils dominate thermophilous meadows and rock debris grasslands from class *Festuco-Brometea*. Because these are habitats of many threatened and rare plants, they are extremely valuable both on local and regional, European scale. On deeper forms of soils occur mesophilous grasslands from class *Molinio-Arrhenatheretea* including also communites from endemic alliance *Pančićion* and acidophilous Dinaric alliance Agrosti-Festucion which encompass communities with endemic character.

In the EUNIS classification of habitat types, special place take swamp like habitats with communities from alliance *Caricion davallianae* and *Molinion coeruleae* which comprise communities that are endemic and considered to be glacial relicts.

This vegetation type provides shelter for many endemic, rare and threatened species that are on to be found on diverse Red Lists, such as : *Scabiosa leucophylla, Scorzonera rosea, Scorzonera villosa, Geum molle, Molinia coerulea, Eriophorum laifolium, Menyanthes trifoliata* and other species that represent highly significant part of biodiversity, not only in Dinaric but also in European region.

Number of species declines from thermophilous toward mesophilous and hygrophilous communities, thus it varies between 55 species that are detected in thermophilous community *Carici-Scabiosetum* and 21 species that are detected in hygrophilous community *Eriophoro-Menyanthetum.* It indicates that these communities with moderate floristic richness, but with a lot of endemic and relicts plant species.

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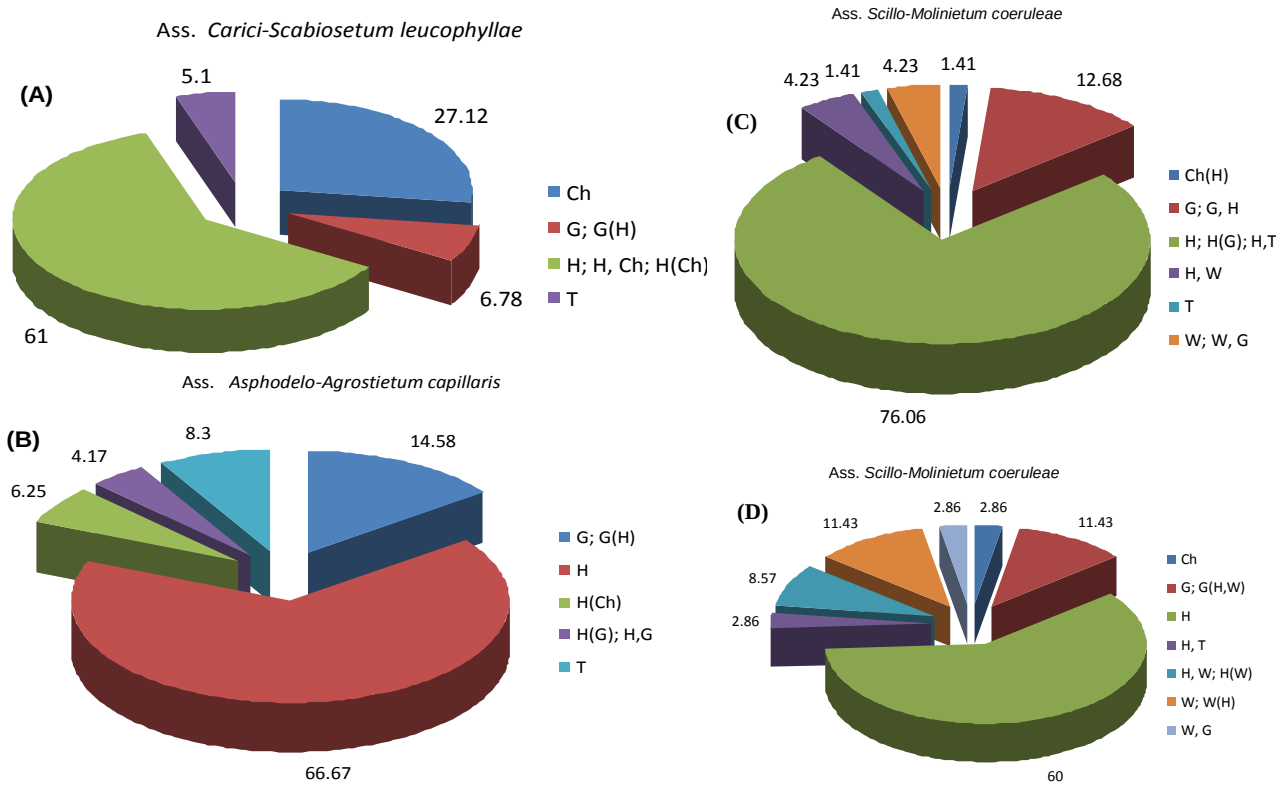

Figure 7. Spectrum of life forms of investigated plant communities (Legend: Ch – Chaemophytae H – Hemicryptophytae G – Geophytae T – Therophytae W – Water plants). (A) Ass. *Carici-Scabiosetum (B) Ass. Asphodelo-Agrostietum capilaris* (C) Ass. *Scillo-Molinietum coeruleae* (D) Ass. *Eriophoro-Menyanthetum trifoliati.*

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