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Original Article

Distibution of *Calthion palustris* Tüxen 1937 in Eninska River Basin, Central Stara Planina Mountain

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***Abstract*:**
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During a phytocoenological investigation of Eninska river basin in Central Stara Planina Mountain the wetland vegetation proved to be an element of *Calthion* alliance. This conclusion is made on the basis of cluster analysis applied by the computer program SYN-TAX and a detailed review of species composition of the analyzed relevés with the respective comparisons. The alliance is presented by the Central European *ass. Filipendulo ulmariae-Menthetum longifoliae*. The Balcan influence over the association is apparent from the Balcan endemic species *Angelica pančičii* and *Dactylorhiza incarnata.* The association is dependent on water sufficiency and unifies *Mentha longifolia* grasslands on nutrient soils with slightly acidic to slightly basic reaction. It is anthropogenically influenced. Some stands form *Mentha longifolia* and *Urtica dioica* community.

Key words: *Calthion*, Central Stara Planina Mountain, cluster analysis

Introduction

Vegetation of *Calthion palustris* Tüxen 1937 alliance has been profoundly investigated in Europe by many authors (Sýkora, 1982, Randjelović & Zlatković, 1994, Hájková et al., 2006, Hájková, 2008 and others). During the last decade the studies on this type of vegetation in Bulgaria according to the principles of Braun-Blanquet phytosociological school also have increased and generalized by Tzonev et al. (2009). Still, there are gaps in this field especially in the conditions of continuously changing environment.

The present research is a part of a phytocoenological investigation of Eninska river basin situated on the Southern slopes of Central Stara Planina Mountain. Different types of forest and grass communities form the vegetation cover of the region. The present paper deals only with hygro- and mesohygrophyte tall-herb coenosis (wetlands) distributed along and around the river and its tributaries. The aim of the investigation is put in this context: clearing up the syntaxonomy and habitat affiliation of these communities as referred in the available papers and investigations (Mucina, 1997; Rodwell et al., 2002; Hájek et al., 2008; Tzonev et al., 2009 and others).

Materials and methods

Object of investigation. Eninska river basin covers about 7 000 ha area on the southern slopes of Central Stara Planina Mountain (**Fig. 1**). The altitude range it takes is from 500 m a.s.l. (the lowest point) to 1450 m a.s.l. (at the main ridge). Shipchenski anticlinorium is the basic geological

structure in the region. It is presented by Paleozoic granitoids in the core and calcareous rocks in the mantle of Triassaic, Jurassic and early Cretaceous age (Jordanova et al., 2002). The topographic forms are very rough because of the steep slopes and the deeply indented gorges and tributaries of the river which in its low stream forms the almost vertical and narrow Eninsko zhdrelo (Enina gorge). Warm summer and cold winter characterize the climate of this region complimented by the following features - big annual amplitude of temperature, spring-summer and winter maximum of precipitations and yearly stable snow cover (Velev, 2002). Stara Planina Mountain is an example of a mountain variant of temperate-continental climate – colder and damper. Temperature decreases and wind, precipitation and clouds increasewith an increase of altitude.

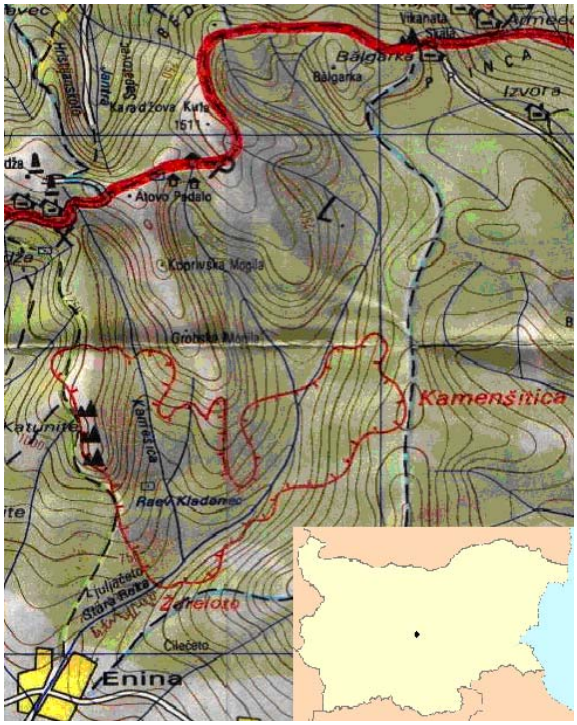

Figure 1. Geographical position of the studied area

Soil diversity in the region is presented mainly by brown forest soils (Eutric Cambisols according to FAO clasiification) taking predominantly slopes at higher than 700 – 800 m a.s.l. altitudes (Ninov, 2002). There are different types of vegetation in the investigated region normally distributed along the altitudinal gradient – temperate heathlands and grasslands at lower or higher altitude *(Festuco-Brometea, Molinio-Arrhenatheretea)*, temperate broadleaved forests and scrubs *(Querco-Fagetea)*, chasmophytic vegetation and synanthropic vegetation in relation with anthropogenic pressure (Mucina, 1997). The basin includes two protected areas within its borders - the natural reserve "Kamenshtitsa" and the protected site "Eninsko zhdrelo" (Enina gorge). It is also a part of a Nature 2000 protected zone (Central Balkan Buffer).

Methods of investigation. The methods of the investigation follow the principles of the Braun-Blanquet phytosociological school (Westhoff & Maarel, 1973; Mueller-Dombois & Ellenberg; 1974 and others). The terrain work was carried out during the period from 2003 to 2006. The investigated vegetation is presented by 15 relevés made in presentable and comparatively homogeneous sites according to the requirements of the methodology (Kent & Coker, 1992) at the wet lowest points of the relief. 1 relevé is removed from the analysis as transitional and complex. A cluster analysis is applied using the computer program SYN-TAX (Podani, 2000). Average linkage method (UPGMA) is used and floristic similarity among relevés is evaluated according to Horn's index.

The diagnostic species for the revealed vegetation groups are determined after a detailed review and comparisons with the referred literature. The species determination and taxonomical nomenclature is according to Flora of Bulgaria (Yordanov (ed.), 1963–1989, Kozhuharov (ed.), 1995) and the Field guide to the vascular plants in Bulgaria (Andreev et al., 2002). Floral elements are determined according to Assyov (2006). Raunkiaer's life forms are also indicated (Goruishina, 1979). The nomenclature of syntaxa and habitat diversity is according to Rodwell et al. (2002).

Results and discussion

The cluster analysis resulted in the differentiation of two comparatively heterogeneous groups, both belonging to *Calthion palustris* Tüxen 1937 alliance from *Molinio-Arrhenateretea* Tüxen 1937 class (**Fig. 2**, **Tab. 1**). The floristic similarity between relevés in the first group consisting of 9 relevés is of 35%. According to some authors (Theurillat & Matthey, 1987, Tzonev, 2002) this is enough in order for the group to be considered one association. Dominant species are *Mentha longifolia* and *Deshampsia caespitosa* and co-dominants are *Filipendula ulmaria* and *Caltha palustris* in some relevés. Constant species with constancy above III are *Lathyrus pratensis, Filipendula ulmaria, Caltha palustris, Carex hirta* (**Tab. 1**). These together with *Ranunculus repens,*

Myosotis scorpioides, Scirpus sylvaticus, Juncus effusus, Lysimachia nummularia (constancy II and I) form the characteristic species complex of *ass. Filipendulo ulmariae-Menthetum longifoliae* Zlinská 1989 described in Slovakia (Hájková et al., 2008). *Calthion* vegetation is comparatively well studied in Central Europe. Great diversity at association and subassociation level was registered for Slovakia (according to Hájková et al., 2008) where 14 associations were distinguished in *Calthion* alliance. Six of them had been described earlier in Western Carpathians (Hájková et Hájek, 2005). These are *Cirsietum rivularis* Nowiński 1927, *Chaerophyllo hirsuti-Calthetum palustris* Balátová-Tuláčková 1985, *Angelico sylvestris-Cirsietum palustris* Darimont ex Balátová-Tuláčková 1973, *Scirpetum silvatici* Ralski 1931, *Angelico sylvestris-Cirsietum oleracei* Tüxen 1937 and *Scirpo silvatici-Cirsietum cani* Balátová-Tuláčková 1973. *Angelico-Cirsietum oleracei*, *Cirsietum rivularis* and *Scirpetum sylvatici* were recorded for Hungaria (Borhidi, 2003) and Romanian *Calthion* vegetation (Sanda et al., 1999). Ass. *Angelico sylvestris-Cirsietum oleracei* shows some resemblance to *Calthion* communities from Central Stara planina Mountain – it develops on nutrient-rich, mostly alluvial, alkaline soils and forms similar physiognomy with dominant species *Mentha longifolia* and *Filipendula ulmaria* but is distributed at lower altitudes in areas with calcium-rich bedrock. Besides most of the constant species are absent in Central Stara planina Mountain. Ass. *Scirpetum silvatici* has most common distribution in Central and Southeastern Europe. These species poor wet grasslands dominated by *Scirpus silvaticus* and developing on nutrient-rich acidic to alkaline soils (Hájková et al., 2008) are recorded by Hájek et al. (2005) for Vitosha Mountain from Bulgaria.

The central European origin of *Calthion* vegetation is indirectly confirmed by Randjelović & Zlatković (2010). They treat *Calthion* vegetation of Vlasina plateau and record three associations - *Equiseto-Scirpetum silvaticae* Šegulja 1974, *Polygono-Scirpetum silvaticae* Schwick. 1944 and the locally distributed *Brachythecio-Menthetum longifoliae* V. Randj. 2001. Although the Euro-Asian, Boreal and Holarctic elements prevail in the phytogeographical specters of the three associations the Balkan influence is discernible by Balkan endemic species in the composition of *Polygono-Scirpetum silvaticae* and *Brachythecio-Menthetum longifoliae*. In synecological respect *Calthion* vegetation from Vlasina plateau is similar to the same in Central Stara planina Mountain – these are waterlogged wet grasslands on acidic soils with well-developed humus horizons distributed in the subalpine belt. There are more considerable differences in the constant species at association level with *Calthion* communities from Central Stara planina Mountain.

It could be concluded that the major group of *Calthion* communities (9 relevés) in Eninska river basin shows great resemblance in ecology and species diversity with *ass. Filipendulo ulmariae-Menthetum longifolie* Zlinská 1989 described in Slovakia (Hájková et al., 2008). This association unifies grasslands dominated by *Mentha longifolia* on nutrient-rich soils in small alluvia with slightly acidic to slightly basic groundwater reaction as described by Hájková (2008) for the Slovakian *Molinio-Arrhenatheretea* vegetation. Here, it is marked by almost the same complex of constant species. In the context of the habitat differentiation of wet grasslands in Bulgaria made by Hájek et al. (2008) the discussed vegetation group is most likely to be a part of the sub-montane waterlogged grasslands on alkaline soils of *Calthion* wetland vegetation. It also resembles the intermittently *Deschampsion* alliance with diagnostic species *Alopecurus pratensis, Carex otrubae, Carex spicata, Juncus compressus, Potentilla reptans*. But most of the diagnostic species of that alliance are either not present or occur with low constancies in the discussed group. The exposed arguments give reason to consider "our" *Calthion* group as an element of the Central European *Filipendulo ulmariae-Menthetum longifoliae*. In Central Stara Planina Mountain however this association is normally modified by the presence of *Angelica pančičii* and *Dactylorhiza incarnata* as Balkan floral elements. Thus in the present case it could be considered as a Balkan variant of the Central European association. It takes stands on silicate bedrock at 1200 – 1450 m a.s.l. and predominantly Southern slopes of 15–30 degrees inclination. Moss layer is poorly presented. The association has comparatively heterogeneous horizontal structure – mosaics are character feature (**Fig. 3**). This is caused by the irregularity of the environmental conditions typical for this type of vegetation. Being located on the watersides of the river and its tributaries it is dependent on water sufficiency.

Actually, *Mentha longifolia* forms different types of communities. Sýkora (1982) discusses the syntaxonomy and synecology of *Junco-Menthetum longifoliae* Lohmeyer 1953 and *Caricetum vulpinae* Nowinsky 1927 distributed from the Northern part of Europe through Central to Southeastern Europe. The author distinguishes conglomerates in these associations on the basis of ecological variations and differences obtained by

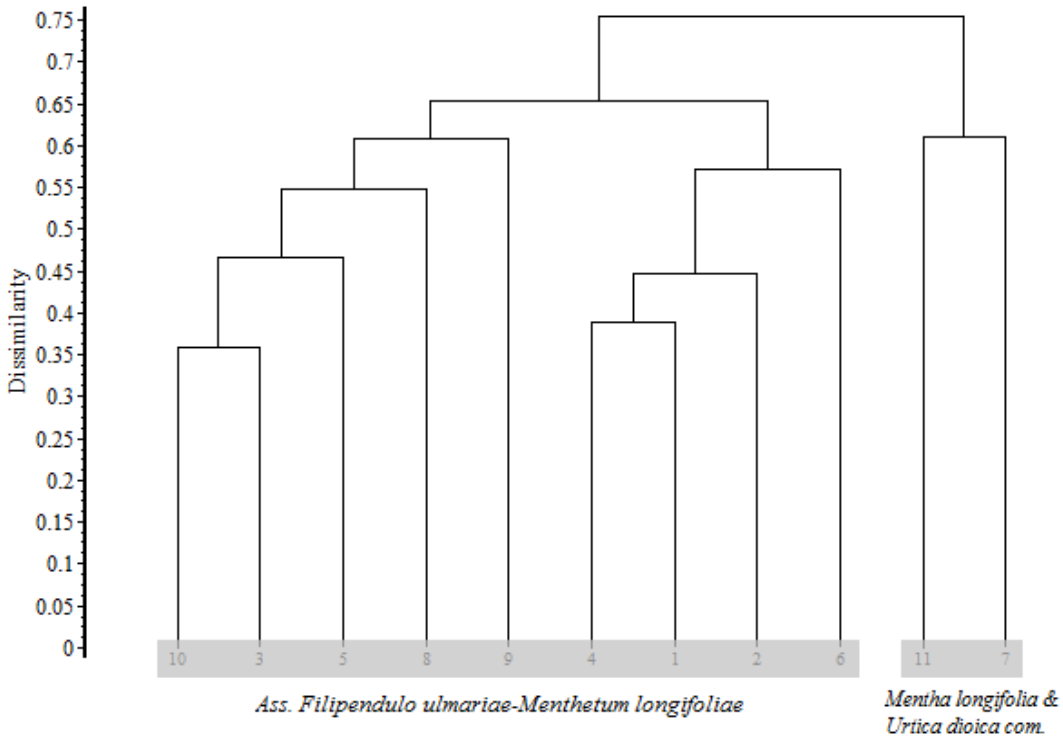

Figure 2. Classification dendrogram of the wetland relevés from Eninska river basin made in the computer program SYN-TAX (Podani 2002)

Figure 3. The heterogeneous structure gives a characteristic appearance of *Calthion* vegetation

Table 1. Phytosociological table of *Calthion palustris* Tüxen 1937 communities in Eninska river basin, Central Stara Planina Mountain

Releve number	10	3	5	8	9	4	1	2	6		11	7	
Relevé area (m^2)	100	100	100	100	100	100	100	100	100	Constancy	100	100	Constancy
Altitude (m)	1450	1400	1400	1200	1400	1400	1430	1400	1400		1000	1200	
Aspect	S	S	S	S	S	W	S	S	S		E	S	
Slope (degrees)	30	30	15	10	15	25	30	20	15		30	15	
Cover total (%)	100	100	100	100	100	100	100	100	100		100	100	
	***Ass. Filipendulo ulmariae-Menthetum longifoliae* Zlinská 1989**										***Mentha longifolia & Urtica dioica com.***		
Lathyrus pratensis		+	+			+	+	+	+	IV	+		III
Carex hirta		+	+		+		+	+		III	+		III
Filipendula ulmaria	1		+	+		3	3			III		+	III
Caltha palustris						+	+	1	2	III			-
Ranunculus repens				+		+			+	II			-
Myosotis scorpioides			+			+				II		+	III
Scirpus sylvaticus							+			I			-
Juncus effusus					+					I			-
Lysimachia nummularia			+							I			-
Mentha longifolia	+	2	4	+						III	2	3	V
Urtica dioica	+			+			+	+		III	2	2	V
***Calthion palustris* Tüxen 1937**													
Deschampsia caespitosa	+	1	1			1	3	4	+	IV	1		III
Equisetum palustre	2	2		2	2	+		+		IV			-
Dactylorhiza saccifera	+	+		+	+	+		+	+	IV			-
Galium palustre			+		+	1	+	+	+	IV			-
Hypericum tetrapterum		+	+	+	+			+		III	+	+	V
Ranunculus acris			+		+			+	+	III			-
Potentilla erecta	+	+	+					+		III			-
Dactylorhiza incarnata						+	+	+		II	1		III
Carex echinata			+		+	+				II		+	III
***Molinietalia* W. Koch 1926**													
Prunella vulgaris	+	+	+	+	+			+	+	IV	+	+	V
Carex ovalis	+	+	1		+	+	+	+		IV			-
Juncus articulatus						+	+	+		II	+		III
Trifolium pratense				+				+		II	+		III
Angelica sylvestris				+						I	2		III
***Mulgedio-Aconitetea* Hadač et Klika in Klika 1948**													
Angelica pancicii	1	1	+	1	+		+	+	2	V			-
Alchemilla glabra	1	1	+	+		+	+	+	+	V			-
Geum rivale			+		+	+	+	+	+	IV			-
***Molinio-Arrhenatheretea* Tüxen 1937**													
Juncus compressus						+			1	II			-
Poa palustris						+	2			II			-
Blysmus compressus					1					I			-
Carex otrubae									+	I	+		III
Cynosurus cristatus								+		I			-
Potentilla reptans					+					I			-
Glyceria plicata			+							I			-
Dactylis glomerata										-		+	III
Rumex crispus										-	+		III
***Galio urticetea* Passarge ex Kopecký 1969 *and Epilobietea angustifoliae* Tx. & Preising ex von Rochow 1951**													
Rubus idaeus	+		+	+					+	III			-
Rumex alpinus						+		+		II			-
Fragaria vesca	+		+							II	+		III

Salix caprea				+	+				II			+	III
Geum urbanum	+								I				-
Stachys sylvatica				+					I		+	+	V
***Nardo-Callunetea* Preising 1949, *Festuco-Brometea* Braun-Blanq. et Tüxen ex Soó 1947, *Querco-Fagetea* Braun-Blanq. et Vlieger in Vlieger 1937**													
Potentilla recta gr.									+	I			-
Stellaria graminea	+									I	+		III
Bruckenthalia spiculifolia			+							I			-
Chamaespartium sagittale			+							I			-
Lerchenfeldia flexuosa			+							I			-
Festuca dalmatica								+		I			-
Hypericum perforatum									+	I			-
Lotus corniculatus				+						I			-
Cruciata laevipes									+	I	+		III
Verbascum longifolium ssp. pannosum								+		I			-
Heracleum sibiricum				+						I			-
Carex sylvatica		+								I			-
Calystegia sepium								+		I			-
Dryopteris filix-mas									+	I			-
Calamagrostis arundinacea										-		+	III
Digitalis grandiflora										-	+		III
Clinopodium vulgare										-	+		III
Geranium rotundifolium										-	+		III
Acer platanoides										-		+	III
Others										-			-
Athyrium filix-femina	1	+	+	+	+				+	IV			-
Mentha spicata		2	+			3		1	3	III			-
Inula helenium	+	+	+	1						III		+	III
Veronica anagallis-aquatica			+		+	+	+			III			-
Epilobium nutans	+		+		+					II		+	III
Stachys alpina	+							+		II			-
Ranunculus ophioglossifolius			+				+			II			-
Marchantia polymorpha			+		+					II			-
Veronica beccabunga						+	+			II			-
Galium album				+						I			-
Carduus nutans	+									I	+		III
Senecio rupestris	+									I			-
Glyceria maxima						1				I			-
Lapsana communis					+					I			-
Rumex sanguineus				+						I			-
Bromus secalinus				+						I			-
Glyceria fluitans			+							I			-
Carex flava			+							I			-
Eleocharis palustris					+					I			-
Cicerbita alpina					+					I			-
Sagina procumbens									+	I			-
Epilobium alpestre			+							I			-
Arctium lappa										-	1	2	V
Equisetum arvense										-	+		III
Telekia speciosa										-	+		III
Torilis japonica										-	+		III
Vicia cracca										-	+		III
Elymus caninus										-	1		III
Geranium phaeum										-	+		III
Pyrola rotundifolia										-	+		III

Principle Component Analysis. The described in the present paper association resembles *Mentha longifolia* and *Hypericum tetrapterum* conglomerate in species composition. The last is based on relevés from former Czechoslovakia at rather lower altitudes (350 – 800 m a.s.l.) and is notable with its open character. As it was already underlined much more resemblance could be found with the described *Calthion* association *Equiseto-Scirpetum sylvaticae* Šegulja 1974, subass. *deschapsietosum caespitosae* Randjelović & Zlatković 1994 in neighbouring Serbia (Randjelović & Zlatković, 1994). Again, these comparisons confirm the Balkan modification of the accepted Central European association.

The second group presented in the table and dendrogram (**Tab. 1**, **Fig. 2**) consisting of 2 relevés belongs to the same alliance *Calthion* but is not given a concrete syntaxonomical rank as it is highly influenced by antropophyte elements. Thus it is determined as *Mentha longifolia and Urtica dioica* community. It indicates habitat degradation and is somehow a "return" in succession. In this community *Mentha longifolia* (constancy V) could be considered as a characteristic species of the nitrophylous alliance *Agropyro–Rumicion crispi* Nordh. 1940 (Tzonev, 2009, Randjelović & Zlatković, 2010) together with *Rumex crispus* (constancy III) and *Urtica dioica* (constancy V). Most of the character species for *Calthion* alliance are presented in this community (**Tab. 1**) and it could not be affiliated to *Agropyro-Rumicion crispi* at present. Future investigations will clarify its succession status.

In accordance with the discussion hitherto the following classification scheme for the hygro- and mesohygrophyte vegetation in Eninska River basin could be proposed:

Class *Molinio-Arrhenatheretea* Tüxen 1937

Order *Molinietalia* W. Koch 1926

Alliance *Calthion palustris* Tüxen 1937

Ass. *Filipendulo ulmariae-Menthetum longifoliae* Zlinská 1989

***Mentha longifolia and Urtica dioica* community**

In addition, geoelements and Raunkiaer's life forms for the species are indicated. The Holarctic group of elements is well presented in *Calthion* communities in the region by the Boreal and subBoreal geoelement - respectively 17% and 15%. It is followed by the Palearctic group including Euroasian (12%) and Eurosiberian elements (9%). European elements are 9%. This distribution corresponds with the Central-European origin of *Calthion* vegetation habitat conditions (climate, relief) – low- and mid-mountain. The sub-European group is presented mainly by Euromediterranean elements (10%) which together with subMediterranean elements (8%) indicates the South-European position of the treated vegetation. Kosmopolitan species are 11%. In the biological specter the hemicryptophytes prevail – 52%, followed by the cryptophytes (helophytes) – 35%. The chamaephytes represent 2%. Closeness with forest belt is apparent by phanaerophytes which take 4%. The percentage of therophytes, not typical for this kind of vegetation, is comparatively high – 7%. Some of them are anthropophytes *(Arctium lappa, Carduus nutans, Lapsana communis)*.

Conclusions

Phytosociological analysis showed distribution of *Calthion* alliance in Eninska river basin, Central Stara Planina Mountain. The alliance is presented by *ass. Filipendulo ulmariae-Menthetum longifoliae* and *Mentha longifolia and Urtica dioica community*. The described association is the optimal wetland vegetation in the subalpine belt of the region. *Calthion* is an azonal vegetation and its structure is determined by nutrient availability, water regime and management practices (Fliervoet & Werger, 1985). Being close to the timber-line it is influenced by *Mulgedio-Aconitetea* Hadač et Klika in Klika 1948 class. The anthropogenic pressure in the region has also influenced the species composition and the condition of *Calthion* communities. This is marked by *Galio-Urticetea* Passarge ex Kopecký 1969 and *Epilobietea angustifoliae* Tüxen & Preising ex von Rochow 1951 species.

The presented analysis is based only on species composition of the described communities. Additional investigations of this type of vegetation and enlarging the region, for example Shipchenska Stara Planina Mountain, are necessary in order to clarify the status and ecological patterns of these communities.

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