Two new associations from the herbaceous riparian vegetation in the Central Danubian Plain, Bulgaria

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Abstract. The paper presents results of the phytocoenological analysis of some riparian herbaceous communities in the Central Danubian Plain, Bulgaria, in the vicinities of Pleven town. One of the associations is new to Bulgaria, while the other one is described for the first time. It also presents a not investigated yet vegetation type according to the Braun-Blanquet's methodology: the tall-herb riverside vegetation of the lowlands.

Key words: aquatic communities, syntaxa, tall herbs.

Introduction

The Central Danubian Plain lies between the Yantra and Vit rivers on the east and west, and between the Danube River and the Forebalkan in the north and south. The average altitude of the terrain is 138 m. The relief is formed by a thick loess cover (50 m) in the northern part and calcareous plateaus in the southern parts. According to Velev (1990), the climate is temperate-continental, with western and northwestern winds and average precipitation between 500 mm and 600 mm per year. According to Ninov (2002), chernozems and phaeozems are the widest spread soils in this part of the country, while luvisols occur seldom in the southern parts. The centre of this geographical region is occupied by the Pleven Heights. They have a calcareous base with loess cover. Several rivers cut them up, the largest of which is river Vit, with its main tributaries Chernelka and Tuchenitsa. Their canyon-like valleys have rich biodiversity and some protected areas like Kayluka Protected Area and Chernelka and Studenets Natural Highlights also fall in there. The water resources of the region are directly related with the here studied vegetation type. These are surface running waters, groundwaters and standing reservoirs, with their qualitative indicators: turbidity, flow, mineralization, etc.

The pronounced continental climate in the region determines the overall relatively low runoff of the area. Due to the high runoff of the Maastricht limestone in the Pleven syncline and the alluvial deposits of river Vit, the Pleven Heighs have greater humidity: 40–50 mm per year. Near the town of Pleven and the Tuchenitsa and Gortalovo villages there are also large unconfined karst springs (Mihayilov & al. 1989, Zyapkov & Yordanova 2002), but they have a little impact on the riparian vegetation. Much more important are the shallow groundwaters which are most frequent in the flooded riverside terraces. Their stocks are very large: on the terrace of river Vit near Sadovets village, the mouth amounted to 38 million m^3. Groundwaters are very important for maintenance of the river flows. During the periods of high water, they take in some of the surplus moisture in the terrace, but during low flow the river drains them down into itself. The construction of dykes, rectification and corrections of river streams in the 1950–1960 s had affected this vital connection. The increasingly eroded fundament (from rectification of meanders) has led to a chiselled river level

and deep drainage of the groundwater from the riverside terrace, especially to river Vit. Water quantity has decreased mostly due to the transit river flow. On the other hand, this has inflicted rapid destructive changes of the soils and vegetation cover in the affected areas (Mihov & Hristov, 2010).

River Vit (3225 km^2) is the main river artery of the area. Basically, a rain-snow regime forms its flow, but the karst sustentation also has its say. During high-water periods, the waters account for about 60–65 % of the annual water amounts. The influence of the karst feeding shifts this maximum to April and May. During the low waters in late summer-autumn, the water masses shrink to 10–12 %. In summer, the effect of precipitation is offset by the enhanced evaporation. The minimum flow is in October. The smaller tributaries like Tuchenitsa and Chernelka are shallow, with a short spring freshet and a long summer-autumn low-water flow. In the rivers crossing the Pleven syncline, the karst feeding plays a significant role in the forming of their flow. The numerous small dry valleys and steep slopes occasionally cause torrential floods (Mihaylov & al. 1989). The average annual flow of river Vit during 1948/49 – 1967/68 was 14.0 m^3/s. Water temperature in the summer months (July and August) varies between 13–23 °C. Some ice (ice-forming takes on the average 36 days) is occasionally observed in the second half of January, but practically the rivers do not freeze out because of their small depth and fast streams. The average turbidity of 400 g/m^3 of river Vit near the village of Sadovets is relatively high due to the drought, erosion, deflation and particularly to the unstable structure of the soils and loess. However, the smaller and shallower tributaries like Chernelka, Kamenitsa and Tuchenitsa are relatively limpid especially in summer. Mineralization of the water of all rivers in the region is relatively low. According to the prevailing dissolved ions in the water, the area belongs mainly to the hydrogen-carbonate-calcium-sulfate hydrofacies and less to the hydrogen-carbonate-calcium-sodium hydrofacies (Yordanova & al. 2002; Mihaylov & al. 1989).

The vegetation of the Central Danubian Plain is rich: steppes, broadleaved forests, wetlands, etc. However, data on the vegetation of this region are scattered and have been collected mostly according to the formerly dominant method of the Russian Phytocoenological School (Stoyanov 1948; Ganchev & Kochev 1962; Kochev & Yordanov 1981; Kochev & al. 1986; Kochev & Tsolova, 1984, 1987; Bondev 1991, etc). The main study of the vegetation of this area according the newly applied in Bulgaria Braun-Blanquet's methodology is subject of the PhD thesis of Tzonev (2002), with subsequent contributions again by Tzonev (2009a, b, 2013). Some of the above-mentioned papers were focused especially on the aquatic communities (Kochev & Yordanov 1981; Kochev & Tsolova 1987; Kochev & al. 1986; Tzonev 2009a). However, herbaceous riparian vegetation in the lowlands has not been investigated not only in this region but also across the country (see Tzonev & al. 2009).

Material and methods

The investigation of the vegetation was carried out in 2016, according to the methods of the sigmatic school (Braun-Blanquet 1964, van der Maarel 2005). During statistical processing, an expanded scale of Braun-Blanquet for abundance/dominance (Braun-Blanquet 1932) was used, transformed according to van der Maarel (1979). Cluster analysis of the relevés was made with SYNTAXA software (Podani 2001). The average linkage method (UPGMA) was applied and floristic similarity among relevés was evaluated according to Horn's Index (Krebs 1999). Taxonomic nomenclature followed Kozhuharov (1992) and Delipavlov & Cheshmedzhiev (2003). New syntaxa were published and validated according to the rules of the International Code of Phytosociological Nomenclature (Weber & al. 2000) and according to the cited references (Horvat & al. 1974; Doniță & al. 1992; Kojić & al. 1998; Sanda & al. 1999; Rodwell & al. 2002). The work of Mucina & al. (2016) was leading in determination of the synoptic scheme. In regard to the investigated communities, most topical information from the neighbouring countries (Slovakia, Hungary, Czech Republic, and Romania) was found in the works of Valachovic 2001; Jarolimek & al. (1997); Jarolimek & Šibik. (2008); Chytry (2009, 2011); Borhidi (2003), Coldea (1997, 2012), etc.

Results

The following syntaxonomic scheme is presented in the paper as a result from the analysis (Fig. 1):

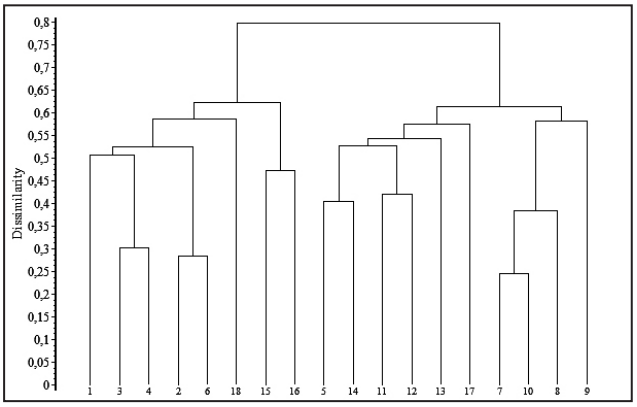

Fig. 1. Numerical analysis of the releves with the SYNTAXA program.

Class *Phragmito-Magnocaricetea* Klika in Klika & Novak 1941

Order *Nasturtio-Glyceiretalia* Pignatti 1953

Alliance *Glycerio-Sparganion* Br.-Bl. et Sissingh in Boer 1942

Association *Leersietum oryzoidis* Eggler 1933

Class *Epilobietea angustifolii* Tx. et Preising ex von Rochow 1951

Order *Convolvuletalia sepium* Tx. ex Moor 1958

Alliance *Archangelicion litoralis* Scamoni et Passarge 1963

Association *Brachypodio sylvatici-Angelicetum sylvestris* ass. nova.

Association *Leersietum oryzoidis* Eggler 1933

Leersia oryzoidis is (L.) Sw. is a widespread species in Bulgaria, mostly along the rivers and in rice fields in the lowlands (Kozhuharov 1992; Delipavlov & Cheshmedzhiev 2003). The species forms monodominant communities, occasionally floating in the shallow water bodies. Only one community was described from the wetlands along the Danube River according to the dominant methodology by Kochev & Yordanov (1981) . No relevés from Bulgaria have been published according to the Braun-Blanquet's school. However, it was assumed that the association *Leersietum oryzoidis* was distributed in Bulgaria on the basis of unpublished data by Šumberova & Tzonev (Šumberova & al. 2011). Šumberova & al. (2011) pointed out that this association is widespread in most countries from the temperate parts of Europe (Serbia, Ukraine, Czech Republic, Austria, Hungary, Germany, France, Romania, etc.).

The communities of this association (Table 1) are established in shallow standing or slowly running waters in the valleys of river Vit and its tributaries Chernelka and Tuchenitza (Pleven region). The species is strongly dominant and occupies the wetlands peripheries at a water depth up to 1 m. It forms small monodominant communities (Fig. 2), from several to several scores of square meters in size. The accompanying species are mostly from the class *Phragmito-Magnocaricetea,* such as *Lythrum salicaria*, *Lycopus europaeus*, *Typha angustifolia*, *Schoenoplectus lacustris,* as well as some other aquatic species (including neophytes) like *Bidens frondosa*, *Persicaria mitis*, etc. Some nitrophilous species – *Rumex obtusifolius*, *Urtica dioica*, *Rubus caesius*, etc. – could also participate in the floristic structure. Due to the ecology of *Leersia oryzoides*, distribution of the species in Bulgaria presumably matches the distribution of the association *Leersietum oryzoidis*. This means that this syntaxon is widespread in many river valleys in North Bulgaria (Iskar, Ogosta, Osam, Yantra, etc.), but also southwards from the Stara Planina Mts – Maritsa, Tundzha, Struma, etc. The communities could be also found in various types of standing water, namely small dams, flooded areas, etc.

Fig. 2. Association *Leersietum oryzoidis* in the Kaylaka Protected Area (photo Rossen Tzonev).

Association *Brachypodio sylvatici-Angelicetum sylvestris* ass. nova hoc loco, holotypus relevé №13, Table 1

This association (Table1) presents a vegetation type which has never been investigated before in Bulgaria – riverine tall-herb vegetation in the plains and lowlands (see Tzonev & al. 2009). It could be compared with the high-mountain tall herbs which were described already in the first study, according to the Braun-Blanquet's school in Bulgaria (Horvat & al. 1937) and subsequently continued by Roussakova (2000).

Table 1. Diagnostic table of the syntaxa.

Number of releve	**5**	**14**	**11**	**12**	**13**	**17**	**7**	**10**	**8**	**9**	**C**	**1**	**3**	**4**	**2**	**6**	**18**	**15**	**16**	**C**
Locality	Kayluka Protected Area	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	Turnene, Vit River	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	**o**	Kayluka Protected Area	Kayluka Protected Area	Kayluka Protected Area	Kayluka Protected Area	Kayluka Protected Area	Turnene, Vit River	Disevica, Vit River	Yasen, Vit River	**o**
Latitude	N43.38086	N43.35286	N43.33971	N43.34194	N43.34140	N43.36959	N43.32730	N43.33813	N43.33307	N43.33396	**n**	N43.73683	N43.37715	N43.37800	N43.35699	N43.38132	N43.37647	N43.41001	N43.41659	**n**
Longitude	E24.62440	E24.53251	E24.54936	E24.54829	E24.53895	E24.47347	E24.54776	E24.54870	E24.54836	E24.54911	**s**	E24.63787	E24.62143	E24.62172	E24.63683	E24.63049	E24.48747	E24.52336	E24.52793	**s**
Sample plot (sq. m)	10	15	20	10	20	8	20	12	10	8	**t.**	20	15	24	9	4	10	6	9	**t.**
Water depth (m)	0	0	0	0	0	1	0	0	0	0	**(%)**	1	1	1	1	1	1	1	1	**(%)**
Vegetation cover	70	90	70	95	90	75	70	90	90	80		80	90	95	90	90	95	85	95	
Data	8/26/2016	9/5/2016	9/5/2016	9/5/2016	9/5/2016	9/15/2016	9/5/2016	9/5/2016	9/5/2016	9/5/2016		8/26/2016	8/26/2016	8/26/2016	8/26/2016	8/26/2016	9/15/2016	9/12/2016	9/12/2016	
Association *Brachypodio sylvatici-Angelicetum sylvestris* ass. nov. nova holotypus nom. rel. 13 hoc loco																				
Angelica sylvestris* L. ssp. *sylvestris	**2b**	**3**	**4**	**4**	**3**	**4**	**3**	**4**	**3**	**3**	**100**						+			**13**
***Brachypodium sylvaticum* (Huds.) P. Beauv.**	+		1	1	1		3	1	2a	1	**80**									**0**
***Bromus ramosus* Huds.**	1	2a	1		2b					2a	**50**									**0**
Diagnostic species for the allinace *Archangelicion litoralis* Scamoni et Passarge 1963 and class *Epilobietea angustifolii* Tx. et Preising ex von Rochow 1951																				
Rubus caesius Sm. var. *aquaticus*		+	2b	2a	1	+	2a	2a	1	1	**90**				2b	1				**25**
Urtica dioica L.	1	2a	1	+		2b					**40**	+	+	1		1	1			**63**
Eupatorium cannabinum L.	2b	2b	+	1	2b		1	2a			**70**									**0**
Glechoma hederacea L.		+	2b	1		2a	1				**50**								+	**13**
Myosoton aquaticum (L.) Moench	2a	1	1		+	+					**50**						+			**13**
Scrophularia umbrosa Dumort.	+	+						2a			**30**									**0**
Epilobium hirsutum L.		2a							+		**20**	2a								**13**
Sonchus arvensis L. ssp. *uliginosus* (M. Bieb.) Nyman				+							**10**		+	2a						**25**
Humulus lupulus L.		1			+						**20**									**0**
Calystegia sepium (L.) R. Br.			+								**10**					1				**13**
Heracleum sibiricum L.			+	+							**20**									**0**
Cucubalus baccifer L.					+						**10**									**0**
Chaerophyllum bulbosum L.									+		**10**									**0**
Geranium robertianum L.	+										**10**									**0**
Geum urbanum L.	+										**10**									**0**
Symphytum officinale L.											**0**			2b						**13**
Torilis japonica (Houtt.) DC								+			**10**									**0**
Verbascum nigrum L.							+				**10**									**0**

Table 1. Continuation.

Number of releve	**5**	**14**	**11**	**12**	**13**	**17**	**7**	**10**	**8**	**9**	**C**	**1**	**3**	**4**	**2**	**6**	**18**	**15**	**16**	**C**
Locality	Kayluka Protected Area	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	Turnene, Vit River	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	**o**	Kayluka Protected Area	Kayluka Protected Area	Kayluka Protected Area	Kayluka Protected Area	Kayluka Protected Area	Turnene, Vit River	Disevica, Vit River	Yasen, Vit River	**o**
Latitude	N43.38086	N43.35286	N43.33971	N43.34194	N43.34140	N43.36959	N43.32730	N43.33813	N43.33307	N43.33396	**n**	N43.73683	N43.37715	N43.37800	N43.35699	N43.38132	N43.37647	N43.41001	N43.41659	**n**
Longitude	E24.62440	E24.53251	E24.54936	E24.54829	E24.53895	E24.47347	E24.54776	E24.54870	E24.54836	E24.54911	**s**	E24.63787	E24.62143	E24.62172	E24.63683	E24.63049	E24.48747	E24.52336	E24.52793	**s**
Sample plot (sq. m)	10	15	20	10	20	8	20	12	10	8	**t.**	20	15	24	9	4	10	6	9	**t.**
Water depth (m)	0	0	0	0	0	1	0	0	0	0	**(%)**	1	1	1	1	1	1	1	1	**(%)**
Vegetation cover	70	90	70	95	90	75	70	90	90	80		80	90	95	90	90	95	85	95	
Data	8/26/2016	9/5/2016	9/5/2016	9/5/2016	9/5/2016	9/15/2016	9/5/2016	9/5/2016	9/5/2016	9/5/2016		8/26/2016	8/26/2016	8/26/2016	8/26/2016	8/26/2016	9/15/2016	9/12/2016	9/12/2016	
Mentha longifolia (L.) Huds.		2a									**10**									**0**
Association *Leersietum oryzoidis* Eggler 1933											**0**									
***Leersia oryzoides* (L.) Sw.**			1						1		**10**	**4**	**5**	**4**	**4**	**5**	**4**	**4**	**4**	**100**
Diagnostic species for the alliance *Glycerio-Sparganion* Br.-Bl. et Sissingh in Boer 1942 and class *Phragmito-Magnocaricetea* Klika in Klika et Novak 1941																				
Lythrum salicaria L.	1	2b	+	2b	+	+	1	2b			**80**	2a					+		2a	**38**
Lycopus europaeus L.	2a	+		+							**30**	2a	+		2a	1		1		**63**
Solanum dulcamara L.				+	+	1				1	**40**				1	2a				**0**
Berula erecta (Huds.) Coville	+	2b			1		1		1		**50**									**0**
Carex pseudocyperus L.		1	2b	1	+						**40**									**0**
Mentha aquatica L.	1			2b					1		**30**							1		**13**
Sparganium erectum L.					+		1	1	+		**40**									**0**
Iris pseudacorus L.		+			+						**20**									**0**
Typha angustifolia L.				+							**10**							2b		**13**
Carex riparia Curtis											**0**						+			**13**
Schoenoplectus lacustris (L.) Palla											**0**							2b		**13**
Other species																				
Bidens frondosa L.			+		3	+	2a	1	1		**60**		+		+	+	+	+	1	**75**
Ranunculus repens L.	1						2a	1	1	1	**50**									**0**
Periscaria mitis(Schrank) Opiz.					2a	+					**20**				1			+	1	**38**
Carex hirta L.				+			1	2a	+		**40**									**0**
Clematis vitalba L.	+			+							**20**	1					+			**25**
Plantago major L. ssp. *intermedia* (DC.) Arcang.							+	+	1		**30**								+	**13**
Cynodon dactylon (L.) Pers.						2b					**10**							2a	2a	**25**
Equisetum ramosissimum Desf.							+	+	1		**30**									**0**
Rumex conglomeratus Murr.	+	+			+	1	+	+			**60**	+						1	+	**25**

Table 1. Continuation.

Number of releve	**5**	**14**	**11**	**12**	**13**	**17**	**7**	**10**	**8**	**9**	**C**	**1**	**3**	**4**	**2**	**6**	**18**	**15**	**16**	**C**
Locality	Kayluka Protected Area	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	Turnene, Vit River	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	**o**	Kayluka Protected Area	Kayluka Protected Area	Kayluka Protected Area	Kayluka Protected Area	Kayluka Protected Area	Turnene, Vit River	Disevica, Vit River	Yasen, Vit River	**o**
Latitude	N43.38086	N43.35286	N43.33971	N43.34194	N43.34140	N43.36959	N43.32730	N43.33813	N43.33307	N43.33396	**n**	N43.73683	N43.37715	N43.37800	N43.35699	N43.38132	N43.37647	N43.41001	N43.41659	**n**
Longitude	E24.62440	E24.53251	E24.54936	E24.54829	E24.53895	E24.47347	E24.54776	E24.54870	E24.54836	E24.54911	**s**	E24.63787	E24.62143	E24.62172	E24.63683	E24.63049	E24.48747	E24.52336	E24.52793	**s**
Sample plot (sq. m)	10	15	20	10	20	8	20	12	10	8	**t.**	20	15	24	9	4	10	6	9	**t.**
Water depth (m)	0	0	0	0	0	1	0	0	0	0	**(%)**	1	1	1	1	1	1	1	1	**(%)**
Vegetation cover	70	90	70	95	90	75	70	90	90	80		80	90	95	90	90	95	85	95	
Data	8/26/2016	9/5/2016	9/5/2016	9/5/2016	9/5/2016	9/15/2016	9/5/2016	9/5/2016	9/5/2016	9/5/2016		8/26/2016	8/26/2016	8/26/2016	8/26/2016	8/26/2016	9/15/2016	9/12/2016	9/12/2016	
Xanthium strumarium L.					+	+					**20**							1		**13**
Acer negundo L.	+										**10**			+						**13**
Agrostis stolonifera L.						2a		+			**20**									**0**
Althaea officinalis L.			+					1			**20**									**0**
Dipsacus laciniatus L.				+				+			**20**									**0**
Erigeron acer L.		+					+				**20**									**0**
Evonymus latifolius (L.) Mill.						+				+	**20**									**0**
Hedera helix L.	1									1	**20**									**0**
Juncus inflexus L.							1	1			**20**									**0**
Prunella vulgaris L.	+						2a	+		1	**40**									**0**
Prunus cerasifera Erhr.			+				+				**20**									**0**
Rumex obtusifolius L.		+				+					**20**						2a			**13**
Salix alba L.				+		+					**20**									**13**
Amorpha fruticosa L.											**0**							+		**0**
Artemisia absinthium L.		+									**10**									**0**
Artemisia vulgaris L.				+							**10**									**0**
Bidens cernua L.											**0**						1			**13**
Bidens tripartita L.				+							**10**									**0**
Cichorium inthybus L.								+			**10**									**0**
Cornus mas L.							+				**10**									**0**
Echinochloa crus-galli (L.) P. Beauv.					1						**10**									**0**
Elymus caninus (L.) L.				+							**10**									**0**
Fraxinus oxycarpa M. Bieb. ex Willd.											**0**					1				**13**
Galium album Mill.				+							**10**									**0**
Parthenocissus quinquefolia (L.) Planch.											**0**					1				**13**

Table 1. Continuation.

Number of releve	5	14	11	12	13	17	7	10	8	9	Const. (%)	1	3	4	2	6	18	15	16	Const. (%)
Locality	Kayluka Protected Area	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	Turnene, Vit River	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument	Chernelka Natural Monument		Kayluka Protected Area	Kayluka Protected Area	Kayluka Protected Area	Kayluka Protected Area	Kayluka Protected Area	Turnene, Vit River	Disevica, Vit River	Yasen, Vit River	
Latitude	N43.38086	N43.35286	N43.33971	N43.34194	N43.34140	N43.36959	N43.32730	N43.33813	N43.33307	N43.33396		N43.73683	N43.37715	N43.37800	N43.35699	N43.38132	N43.37647	N43.41001	N43.41659	
Longitude	E24.62440	E24.53251	E24.54936	E24.54829	E24.53895	E24.47347	E24.54776	E24.54870	E24.54836	E24.54911		E24.63787	E24.62143	E24.62172	E24.63683	E24.63049	E24.48747	E24.52336	E24.52793	
Sample plot (sq. m)	10	15	20	10	20	8	20	12	10	8		20	15	24	9	4	10	6	9	
Water depth (m)	0	0	0	0	0	1	0	0	0	0		1	1	1	1	1	1	1	1	
Vegetation cover	70	90	70	95	90	75	70	90	90	80		80	90	95	90	90	95	85	95	
Data	8/26/2016	9/5/2016	9/5/2016	9/5/2016	9/5/2016	9/15/2016	9/5/2016	9/5/2016	9/5/2016	9/5/2016		8/26/2016	8/26/2016	8/26/2016	8/26/2016	8/26/2016	9/15/2016	9/12/2016	9/12/2016	
Paspalum paspaloides (Michx) Schribner										+	10									0
Persicaria lapathifolia (L.) Gray.											0						2b			13
Peucedanum alsaticum L.					+						10									0
Prunus spinosa L.					2a						10									0
Robinia pseudacacia L.										+	10									0
Scirpus sylvaticus L.		+	+								20									0
Setaria verticillata (L.) P.Beauv.					2b						10									0
Tordylium maximum L.								+			10									0
Conocephalum conicum (L.) Dum.										+	10									0

The habitat of the lowland type tall herbs is described for Bulgaria in the *Red Data Book of Bulgaria*, vol. 3 (Valchev & al. 2015). The species composition of the prevailing communities and some suggestions about the existing, but still not described higher syntaxa were made in that work. The order *Convolvuletalia sepium* was also mentioned in it. This order has being referred earlier to the class *Galio-Urticetea* (see Chytry 2009, Coldea 2012), but in the latest revision of Mucina & al. (2016) it was referred to *Epilobietea angustifolii*. The latter was described for Bulgaria for the first time by Dimitrov (2004) and the new association included in it was also described.

The new association identified here (Fig. 3) is referred to the alliance *Angelicion litoralis* Scamoni et Passarge 1963. This alliance has not been reported so far for the Balkan vegetation. Lanikova & al. (2009) accepted it as part of *Senecionion fluvilatilis* (with the synonym names *Calystegion sepium* and *Epilobion hirsuti*), which is well known from the neighbouring countries to Bulgaria, such as Romania (Coldea 2012). According to Lanikova & al. (2009), the alliance includes natural vegetation types of annual and perennial nutrient- and moisture-demanding herbaceous plants. The stands are dense, involving several herbaceous lianas and herbs producing a large amount of biomass. The natural communities grow mostly on the fringes and clearings of the floodplain forests of the investigated vegetation in this study. In the latest European revision of Mucina & al. (2016) though, *Archangelicion litoralis* is described as "tall-herb fringe vegetation on river banks of Central and Eastern Europe". According to Dengler & al. (2004), the differences between both alliances are as follows: *Senecinion fluviatilis* is more typical for large rivers, with great fluctuations in the water level, while *Archangelicion litoralis* is more typical of smaller rivers with less significant changes in the water level across the year. This corresponds to the ecology of communities from the study in this paper.

As the alliance *Archangelicion litoralis* has not been so far recognized for the Balkans, only the associations from *Senecionion fluviatilis* were compared here with the described communities. These associations described from Romania (Coldea 2012), Hungary (Borhidi 2003), Czech Republic (Lanikova & al. 2009), and Slovakia (Jarolimek

Fig. 3. Association *Brachypodio sylvatici-Angelicetum sylvestris* in the Chernelka Natural Highlight (photo Rossen Tzonev).

& Sibik 2008) are dominant or differentiated in a more common species complex along the Danube River or at the foothills and low-mountain regions in Bulgaria, namely *Impatiens glanduligera*, *I. noli-tangere*, *Petasites hybridus*, *P. kablikianus*, *Lunaria rediviva*, *Carex pendula*, *Echinocystis lobata*, *Sicyos angulatus*, *Glycyrrhiza echinata*, etc. Similar associations are *Calystegio sepium-Epilobietum hirsuti* Hilbig & al. 1972 or *Cuscuto europaeae-Calystegtieum sepium* Tuxen ex Lohmeyer 1953. However, they have a more different floristic and physiognomic structure. The first one has a poorer species composition; the second is with more herbaceous lianas. Both lack the typical tall herbs like *Angelica sylvestris*. The shadow-tolerant grasses like *Bromus ramosus* were also absent from the so far known syntaxa from other geographical regions not very far from North Bulgaria. This was the reason for describing the new association and also the first report of the alliance *Archangelicion litoralis* for the Balkans.

The new association is distributed along the rivers in the transitional zone between the Danubian Plain and the Forebalkan. It occurs mostly on calcareous ground and its main peculiarities are described in the Introduction. More typical is the late-summer (August-September) maximum development of tall-herb vegetation because of the lowest water level and denuding gravel bars, or soils with high moisture.

The community appearance is formed by the tall herbs, mostly *Angelica sylvestris*, but also *Eupatorium cannabinum*, *Lythrum salicaria*, *Epilobium hirsutum,* and *Bidens frondosa*. There is also a sublayer of short and creeping herbs like *Glechoma hederacea*, *Ranunculus repens*, *Mysoton aquaticum*, etc. Lianas are not so numerous but, species like *Rubus caesius*, *Cucubalus baccifer*, *Clematis vitalba*, *Humulus lupulus*, and *Calystegia sepium* could also be found in the floristic structure of these communities. Grasses like *Bromus ramosus* and *Brachypodium sylvaticum* (the name-giving taxon of the association) indicate the relationships and genesis of these communities – with the alluvial forest galleries dominated by *Salix alba*, *S. fragilis*, *Populus alba*, etc. Tall-herb communities grow naturally on the forest fringes of such forests, but could also exist independently from the forest succession in suitable for them places. The floristic structure indicates high presence of nitrophilous species, mostly because of the primary eutrophic and nitrophilous conditions in the deep river valleys. Species like *Urtica dioica*, *Rubus caesius*, etc. are well presented in this vegetation and are indicators of nitrogen soil pollution. The naturalness of the newly described association is comparatively high, because only one invasive (neophyte) species, *Bidens frondosa*, has registered a high presence (60 %) in the communities.

Geographical distribution of the new association presumably is not restricted only to the middle stream of river Vit and its tributaries Chernelka and Tuchenitsa. Very similar species compositions were also observed by the author in the basin of river Iskar and its tributaries Panega and Ruchene rivers and many others. In summary, the newly described association has wider distribution, especially along the rivers in the Forebalkan region and the southern calcareous part of the Danubian Plain. It includes the middle streams of Danube's tributaries Ogosta, Vit, Osam, Iskar, Yantra, Rusenski Lom, and their smaller tributaries Chernelka, Tuchenitsa, Kamenitsa, Rositsa, Burzia and many others.

Discussion

Two associations – one new to Bulgaria and one new to science – are presented in the paper. The alliance *Archangelicion litoralis* is also reported for the first time for Bulgaria and probably for the Balkan Peninsula too. It extends its distribution reported by Mucina & al. (2016) for Central and East Europe to the southeastern part of the continent. If researches of tall-herb communities in Bulgaria will continue along the Danube and the rivers in the southern lowland part of the country, such as Maritsa, Tundzha, Arda, etc., they will significantly enhance the number of the newly described for the country and probably for Europe syntaxa from tall-herb vegetation. Existence of several associations of *Senecionion fluviatilis* could certainly be expected, such as *Cuscuto europae-*

ae-Calystegietum sepium Tuxen ex Lohmeyer 1953, *Calystegio sepium-Epilobietum hirsuti* Hilbig & al. 1972, and *Sicyo angulatae-Echinocystietum lobatae* Fijalkowski ex Brzeg et Wojterska 2001. New investigations in the low- and middle mountain areas will also identify some other alliances of tall-herb communities like *Aegopodion podagrariae* Tuxen 1967, *Petasition hybridi* Sillinger 1933, *Impatienti noli-tangere-Stachyion sylvaticae* Gors et Mucina 1993, etc. This paper is another proof how little the vegetation of Bulgaria has been studied according to the dominant in Europe methodology of Braun-Blanquet and how many further efforts are needed.

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References

Bondev, I. 1991. The Vegetation of Bulgaria. Map M 1:600 000 with explanatory text. Sofia Univ. Press, Sofia (in Bulgarian).

Borhidi, A. 2003. Plant Associations of Hungary. Akadémiai Kiadó, Budapest (in Hungarian).

Braun-Blanquet, J. 1932. Plant Sociology. McGraw-Hill, New York.

Braun-Blanquet, J. 1964. Pflanzensoziologie. Grundzüge der Vegetationskunde. Springer-Verlag, Wien and New York.

Chytrý, M. (ed.). 2009. Vegetation of the Czech Republic 2. Ruderal, Weed, Rock and Scree Vegetation. Academia, Praha, 520 p. (in Czech with English summaries).

Chytry, M. (ed.). 2011. Vegetation of the Czech Republic. 3. Aquatic and Wetland Vegetation. Academia, Praha. Hardback, 827 p. (in Czech with English summaries).

Coldea, G. (ed.). 1997. Les associations vegetales de Roumanie. Tome 1. Les associations herbacees naturelles. Press. Univ. Cluj, Cluj-Napoca, 261 p.

Coldea, G. (ed.). 2012. Les associations v eg etales de Roumanie. Tome. 2: Les associations anthropogenes. Press. Univ Cluj, Cluj-Napoca, 482 p.

Delipavlov, D. & Cheshmedzhiev, I. (eds). 2003. Key to the Plants in Bulgaria. Agrarian Univ. Acad. Press, Plovdiv (in Bulgarian).

Dengler, J., Koska, I., Timmermann, T., Berg, C., Clausnitzer, U., Isermann, M., Linke, C., Päzolt, J., Polte, T., Spangenberg, A. 2004. New descriptions and typifications of syntaxa within the project 'Plant communities of Mecklenburg-Vorpommern and their vulnerability' – Part II. Fed. Repert., 115: 343–392.

Dimitrov, M. 2004. Floristic and phytosociological investigation of secondary herbal vegetation in coniferous forest ecosystems. – Forest Ideas, 1: 32-42 (in Bulgarian).

Doniță, N., Ivan, D., Coldea, G., Sanda, V., Popescu, A., Chifu, T., Paucă-Comănescu, M., Mititelu, D. & Boșcaiu, N. 1992. Vegetation of Romania. Tehnicá Agricolá, Buckarest (in Romanian).

Ganchev, S. & Kochev, H. 1962. La Vegetation Gazonnante de la Vallé de la R. Stoudena. – Izv. Bot. Inst. (Sofia), 9: 43-78. (in Bulgarian).

Horvat, I., Glavač, V. & Ellenberg, H. 1974. Vegetation Südo-Osteuropas. G. Fischer Verlag, Stuttgart.

Horvat, I., Pawlowski B. & Walas, J. 1937. Phytosoziologische Studien über die Hochgebirgsvegetation der Rila Planina in Bulgarien. – Bull. Acad. Polon. Scien. Lett. Math. Natur., ser. B: 159-189.

Jarolimek, I. & Šibik, J. (eds). 2008. Diagnostic, Constant and Dominant Species of the Higher Vegetation Units of Slovakia. Veda, Bratislava, 332 p.

Kochev, H. & Yordanov, D. 1981. Vegetation of Bulgarian Water Bodies. Ecology, Protection and Economic Importance. Bulg. Acad. Sci. Press, Sofia. (in Bulgarian).

Kochev, H., Husák, S. & Oťaheľová, H. 1986. Materials on the phytosociological characteristics of the aquatic and marsh vegetation along the eastern stretch of Danube River in Bulgaria. – In: **Nediyalkov, S., Kochev, H., Michev, T., Damiyanova, A. & Velev, V.** (eds), Proc. Intl. Symp. "The Role of Wetlands in Preserving the Genetic Material", Srebarna. Pp. 81-98. Bulg. Acad. Sci. Press, Sofia (in Russian).

Kochev, H. & Tsolova, I. 1984**.** Phytocoenological investigations of Persinski Blata Reserve. – In: **Velchev, V.** (ed.), Proc. Contempt. Teor. App. Asp. Veg. Ecol. 1: 148-156 (in Bulgarian).

Kochev, H. & Tsolova, I. 1987. Ecological investigation of Lugut-Drumkata Protected Area, Pleven District. – In: Proc. Third Natl. Conf. Bot., 3: 215-219 (in Bulgarian).

Kojić, M., Popović, R. & Karadžić, B. 1998. Syntaxonomic Overview of the Vegetation of Serbia. Inst. Biol. Istraž. "S. Stanković" Press., Belgrade (in Serbian).

Kozhuharov, S. (ed.). 1992. Field Guide to the Vascular Plants in Bulgaria. Naouka & Izkoustvo, Sofia (in Bulgarian).

Krebs, C. 1999. Ecological Methodology. 2 Ed. Benjamin-Cummings publ., Menlo Park, California.

Lanikova, D., Koci, M., Sadlo, J., Šumberova, K., Hajkova, P., Hajek, M. & Petrik, R. 2009. Nitrophilous perennial vegetation of wet and mesic habitats. – In: **Chytrý, M.** (ed.), 2009. Vegetation of the Czech Republic 2. Ruderal, Weed, Rock and Scree Vegetation. Academia, Praha: Pp: 289-378 (in Czech with English summaries).

Maarel, E. van der. 1979. Transformation of cover-abundance values in phytosociology and its effect on community similarity. – Vegetatio, **39**(2): 97-114.

Maarel, E. van der (ed.). 2005. Vegetation Ecology. Blackwell Publ., Oxford.

Mihov, S. & Hristov, I. 2010. Conservation and Restoration of River Corridors. WWF, Geosoft LTD, Sofia. (in Bulgarian).

Mihaylov, C., Tishkov, H., Zyapkov, L. & Gorunova, D. 1989. Danube plainy-hilly region. – In: **Mishev, K.** (ed.), Geography of Bulgaria. Vol. 3, Physico-Geographic and Socioeconomic Regionalization of Bulgaria, Publ. House of BAS, Sofia: 29-65 (in Bulgarian).

Mucina, L., Bültmann, H., Dierßen, K., Theuriat, JP., Raus, T., Čarni, A., Šumberová, K., Willner, W., Dengler, J., Gavilán García, R., Chytrý, M., Hájek, M., Di Pietro, R., Iakushenko, D., Pallas, J., Daniëls, F., Bergmeier, E., Santos Guerra, A., Ermakov, N., Valacovič, M., Schaminée, J., Lysenko, T., Didukh, Y., Pignatti, S., Rodwell, J., Capelo, J., Weber, H., Solomeshch, A., Dimopoulos, P., Aguiar, C., Hennekens, S. & Tichý, L. 2016. Vegetation of Europe: Hierarchical floristic classification system of vascular plants, bryophytes, lichen, and algal communities. – Appl. Veget. Sci. **19**(1): 3-264.

Ninov, N. 2002. Soils. – In: **Kopralev, I. (**ed.), Geography of Bulgaria. Physical Geography. Socioeconomic Geography. Pp. 277-315. ForCom, Sofia (in Bulgarian).

Podani J. 2001. SYN-TAX 2000. Computer Programs for Data Analysis in Ecology and Systematics. Users Manual. Scientia, Budapest.

Rodwell, J., Schaminée, J., Mucina, L., Pignatti, S., Dring, J. & Moss, D. 2002. The Diversity of European Vegetation. An Overview of Phytosociological Alliances and their Relationships to EUNIS Habitats. Landbouw, natuurbeheer en visserij, Wageningen.

Roussakova, V. 2000. Végétation alpine et sous alpine superiore de la montagne de Rila (Bulgarie). – Braun-Blanquetia, 25: 3-132.

Sanda, V., Popescu, A. & Arçus, M. 1999. Critical Revision of the Plant Communities in Romania. Tilia Press Int., Constanța (in Romanian).

Stoyanov, N. 1948. The Vegetation of the Danube Islands and their Economic Use. Bulg. Acad. Sci. Press, Sofia (in Bulgarian).

Sumberova, K., **Hajkova, P., Chytry, M., Hroudova, Z., Sadlo, J., Hajek, M., Hrivnak, R., Navratilova, J., Hanakova, P., Ekrt, L. & Ekrtova, E.** 2011. Marsh vegetation. – In: **Chytry, M.** (ed.), 2011. Vegetation of the Czech Republic. 3. Aquatic and Wetland Vegetation. Academia, Praha. Hardback: 385-579. (in Czech with English summaries).

Tzonev, R. 2002. Flora and vegetation of the Middle Danubian Plain between the valleys of Vit and Studena Rivers. *PhD Thesis*. Biol. Fak., Sofia Univ. St. Kliment Ohridski, Sofia (in Bulgarian, unpubl.).

Tzonev, R. 2009a. Plant communities, habitats and ecological changes in the vegetation on the territory of three protected areas along the Danube River. – In: **Ivanova, D.** (ed.), Proc. Fourth Balkan Bot. Cong., Sofia 2006. Pp. 321-331. Publishing House Bulg. Acad. Sci., Sofia.

Tzonev, R. 2009b. Syntaxonomy of the natural and semi-natural vegetation of the Middle Danube Plain in Bulgaria. – Biotechnol. & Biotechnol. EQ. 23/2009/SE, Special edition – on-line: 354-359.

Tzonev, R. 2013. New plant associations from Danubian Plain, Bulgaria. – Phytol. Balcan. **19**(2): 233-256.

Tzonev, R., Dimitrov, M. & Roussakova, V. 2009. Syntaxa according to the Braun-Blanquet approach in Bulgaria. – Phytol. Balcan. **15**(2): 209-233.

Valchev, V., Georgiev, V. & Tzonev, R. 2015. 28E5. Lowland, riverside tall-herb communities. – In: **Biserkov, V., Gussev, Ch., Popov, V., Hibaum, G., Roussakova, V., Pandurski, I., Uzunov, Y., Dimitrov, M., Tzonev, R. & Tzoneva, S.** (eds), Red Data Book of the Republic of Bulgaria. Volume 3. Natural Habitats. Sofia (IBER–BAS and MOEW): 196-198.

Velev, S. 1990. The Climate of Bulgaria. Narodna Prosveta, Sofia (in Bulgarian).

Weber, H.E., Moravec, J. & Theurillat, J.-P. 2000. International Code of Phytosociological Nomenclature. 3rd edition. – J. Veg. Sci., **11**, 739–768.

Yordanova, M, Chubrieva, M., **Zyapkov, L., Gergov, G., Karagyzova, Cv. & Genev, M.** 2002. River water. – In: **Kopralev, I.** (ed.), Geography of Bulgaria. Physical Geography. Socioeconomic Geography. Pp. 192-232. ForCom, Sofia. (in Bulgarian).

Zyapkov, L. & Yordanova, M. 2002. Groundwaters. – In. **Kopralev, I.** (ed.), Geography of Bulgaria. Physical Geography. Socioeconomic Geography. ForCom, Sofia: Pp. 192-232. (in Bulgarian).