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Communities of *Phragmites australis* (Cav.) Trin.ex Steud. in the fluvial terrace of Lower Danube: their diversity and structure of the above-ground phytomass

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***Abstract*:**

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Determination of stocks of aboveground phytomass of reed communities in Bulgaria is not well studied yet. This survey is the most detailed study on the stocks of the aboveground phytomass of the reed communities (*Phragmites australis* (Cav.) Trin. Ex Steud.) in Bulgaria. The studied reed beds are formed in the floodplain part of the Danube River. They are located in the fluvial terrace of the river between Archar Village (west) and Srebarna Village (east). As a result of the survey, it was found that the average stocks of the aboveground phytomass of the reed communities reached to 19.78 t/ha. Moreover, 54.04% of the aboveground phytomass is concentrated in the stems of the reed plants. Almost 42% of it is produced by the leaves, and the inflorescences produce less than 5% of the total amount of the phytomass. This study once again demonstrates the important role of reed beds for the normal functioning and development of riparian ecosystems.

Key words: reed communities, primary production, above-ground phytomass, Danube

***Apstrakt*:**

Valchev, V., Georgiev, V., Tsoneva, S.: ***Zajednice Phragmites australis (Cav.) Trin. ex Steud. na fluvijalnim terasama donjeg Dunava: diverzitet i struktura nadzemne biomase. Biologica Nyssana, 8 (1), Septembar 2017: 53-60.***

Količina nadzemne biomase zajednica trske u Bugarskoj još uvek nije dovoljno proučavana. Ovo istraživanje je najdetaljnija studija nadzemne biljne mase zajednice trske (*Phragmites australis* (Cav.) Trin. Ex Steud.) u Bugarskoj. Ispitivane rečne zajednice su formirane u plavnom području Dunava. Locirane su na fluvijalnim terasama reke između sela Arčar (zapad) i Srebarna (istok). Kao rezultat studije, utvrđeno je da su prosečne količine nadzemne biomase zajednice trske do 19,78 t/ha. Štaviše, 54,04% nadzemne biomase koncentrisano je u drškama trske. Skoro 42% nje je produkovano od strane lišća, a cvetovi proizvode manje od 5% ukupne količine biljne biomase. Ovo istraživanje još jednom demonstrira značajnost uloge tršćaka za normalno funkcionisanje i razvoj riparijalnih ekosistema.

Ključne reči: zajednice trske, primarna produkcija, nadzemna biljna biomasa, Dunav

Introduction

Determination of the above-ground phytomass stocks of reed communities is a problem still pending proper investigation in Bulgaria, so there are only few publications with data on this subject in the Bulgarian scientific literature (Kochev & Yordanov, 1981; Kochev & Yurukova, 1984). In 1986-1987, Gergina Baeva (1994) determined the primary biological production of two species, *Phragmites australis* (Cav.) Trin.ex Steud. and *Typha angustifolia* L., which formed comparatively pure associations in the so-called "reed belt" of Srebarna Reserve applying a method for determination of the annual growth of plant biomass (root biomass production). Kochev & Yordanov (1981) devoted modest attention to the issues of biomass, biological productivity and total stocks of the above-ground phytomass of reed communities in their large-scale survey of the flora and vegetation of water bodies in Bulgaria. However, it was not clear from their results how the dry mass was determined as a component of the primary biological production of these coenoses.

Some data on the bioproduction and energy stocks of Common Reed (*Phragmites australis*) and Lesser Bulrush (*Typha angustifolia*) in Bulgaria were also published by Kochev & Yurukova (1984), a few years latter. And these were about Bulgarian publications on the surveys of reed and its communities as phytomass producers.

Material and methods

Reed coenoses (***Phragmitetum communis***) that participate in the structure of the vegetation cover on the territory of the Danube fluvial terrace are investigated in this study. Dominant species of that stands, *Phragmites australis*, was chosen for survey because its phytocoenoses are some of the widest distributed in the river valley and are the greatest producer of above-ground phytomass among the components of grassy vegetation. When growing in river shallows, they develop most powerfully at water depth between 0.2 and 0.6 m and form different in width belts. The transect method was applied, with organized sample plots, in line with the requirements of European Standard EN 14184 (CEN, 2003a) for running waters and international standard CEN TC 230/TG 3/N72 (CEN, 2003b) for standing water bodies.

Macrophytes (higher plants) were described for each sampling plot (Andreev et al., 1992). Plant abundance was assessed according to the 5-grade scale of Braun-Blanquet (Guinochet, 1973). Some objects got more than one description, in order to acquire a better idea of the phytocoenotic specificities of the reed communities formed along the Danube (**Tab. 1**).

Determination of the above-ground phytomass stocks of the reed communities (in this case it coincides with their biological productivity) follows the quantifying method of Milner & Hughes (1968). Field samples were taken from plots sized 50×50 cm (0.25 m²), after the reed has finally formed its inflorescences. Reed stems were cut close up to the soil. They were divided then into fractions (stems, leaves, inflorescences) and their fresh weight was measured, as quickly as possible. An average sample was taken from each fraction to determine the absolute dry weight (ADW) in laboratory conditions. The obtained data were recalculated in kg/m², and then into t/ha of absolute dry matter. The absolute dry weight (ADW) of the vegetation samples was determined following a standard method: by drying at 60 ºC in the course of 24 hours. The number of cut stems at the sampling plot and the number of inflorescences were recorded for each sample. Data obtained on the quantity and distribution of the above-ground phytomass per stem and per community are published in **Table 2**. The same table gives summarized data on the distribution of the above-ground phytomass by fractions and their quantitative participation in the formation of above-ground phytomass. Similarly were determined the stocks of above-ground phytomass of the accompanying species participating in the formation of reed coenoses (**Tab. 3**).

The Latin names of the plants are given according to the Field Guide to the Vascular Plants in Bulgaria (Andreev et al., 1992).

Results and discussion

Strong reproductive capacity is a specific characteristic of the *Phragmites australis* (Cav.) Trin. ex Steud. (Common Reed). Common Reed propagates by seeds and vegetatively, owing to a very good root system (of the rhizome type), which forms typical root suckers, several meters long. They give rise to the young stems and thus new, so far reed-free areas are colonized.

The very mode of vegetative propagation of the species, and probably some of its allelopathic properties, precondition the creation of coenoses, which usually are monodominant and with a comparatively poor species composition of usually 6 to 10 species (**Tab. 1**). Common Reed often forms mixed communities with other macrophytic species with kindred biology, namely *Typha latifolia* L., *Typha angustifolia* L., *Bolboschoenus maritimus* Palla,

Table 1. Species composition of the common reed communities in the fluvial terrace of Lower Danube

Sites	**Orsoya**			**Zagrazhden**	**Kaikusha**	**Kalimok**	**Malak Preslavets**		**Garvan Marsh**		**Srebarna**							**Frequency of occurrence**
Species/Number of transect	1	2	3				1	2	1	2	1	2	3	4	5	6	7	
Phragmites communis	5	5	5	4	5	5	4	4	1	5	5	5	5	4	5	3	3	**17**
Ceratophyllum demersum				+			1	+	+		1		1	1	1	1	1	**10**
Calystegia sepium	+	+			1	+			+			1		1		1	1	**9**
Lycopus europaeus				+			+	+			+	1			1	1	+	**8**
Hydrocharis morsus-ranae				+			+		+				2	1	+			**6**
Typha angustifolia				1	+		1	1	1	+								**6**
Urtica dioica		+										+			1	1	+	**5**
Epilobium hirsutum				+				+	+							+	+	**5**
Lemna trisulca							+	+	+	3			+					**5**
Thelipteri spalustris											1	1		1	1	1		**5**
Bolboschoenus maritimus		+	+				+							+				**4**
Lemna minor				+			1		+				3					**4**
Typha latifolia				+					+						1	1		**4**
Berula erecta							+								1	1	1	**4**
Mentha aquatica			+	+			+											**3**
Alisma plantago-aquatica				+			+	+										**3**
Lysimachia vulgaris				+				+	+									**3**
Potamogeton crispus								+							1	1		**3**
Salvinia natans										2	+		1					**3**
Stachys palustris	+	+																**2**
Cirsium arvense	+					+												**2**
Sambucus ebulus		+				+												**2**
Myosotis palustris				+				+										**2**
Persicaria hydropiper				+											+			**2**
Schoenoplectus lacustris				+					+									**2**
Veronica beccabunga gr.				+				+										**2**
Bidens tripartita							+							+				**2**
Sparganium erectum							+			+								**2**
Lythrum salicaria									+					1				**2**
Rumex hydrolapathum												1		1				**2**
Solanum dulcamara									+						+			**2**
Symphytum officinale		+																**1**

Potentilla reptans			+																		**1**
Bidens cernua				+																	**1**
Myriophyllum spicatum				+																	**1**
Centaurea stenolepis					+																**1**
Convolvulus arvensis					+																**1**
Euphorbia lucida					+																**1**
Lycopus exaltatus					+																**1**
Lapa major						+															**1**
Sanicula europaea						1															**1**
Butomus umbellatus							+														**1**
Elodea nuttallii							1														**1**
Spirodella polyrhiza							1														**1**
Mentha pulegium								+													**1**
Potamogeton lucens										+											**1**
Utricularia vulgaris										+											**1**
Bidens frondosa											+										**1**
Persicaria lapathifolia												1									**1**
Inula germanica														+							**1**
Carex sp.																				+	**1**
Species richness	4	7	4	17		7		6	16	12	13	7	7	7	6	10	11	10	8		

Table 2. Summarised data of the grass-stand samplings of *Phragmites australis* coenoses

Fractions	**Orsoya**			**Oryahovo**	**Gulyantsi**		**Belene**		**Kalimok**	**M.alakPreslavets**	**Garvan**	**Srebarna**			**Average values**
	1	2	3		Milko-vitsa	Dolni Vit	Kaiku-sha	Dekov				Kochka	Island	Bryag	
2010															
Stems															
Fresh weight (g/0.25 m²)	409.7	1075.7	905.7	279.1	336.7	1400.7	168.3		424.7	669.1	1005.7	824.1	1797.1	433.1	748.4
Absolute dry weight (g/0.25 m²)	307.0	461.1	450.9	150.5	193.7	749.5	84.3		228.3	312.7	509.3	344.3	812.1	225.4	371.5
Absolute dry matter (%)	74.9	42.9	49.8	53.9	57.5	53.5	50.1		46.3	53.3	49.4	58.2	54.8	48.0	53.3
Relative participation of the fraction (%)	82.9	57.4	51.2	46.6	46.8	64.7	74.5		53.9	54.9	69.1	67.1	58.6	52.0	58.8
Leaves															
Fresh weight (g/0.25 m²)	207.6	575.6	683.7	269.9	290.7	774.7	62.8		350.7	528.9	414.7	225.9	934.9	353.9	436.4
Absolute dry weight (g/0.25 m²)	63.3	332.4	412.9	138.6	172.8	361.1	27.8		173.3	239.8	227.3	168.7	565.1	207.9	237.8

Absolute dry matter (%)	30.5	57.8	60.4	51.4	59.4	46.6	44.3		49.4	45.4	54.8	74.7	60.5	58.8	53.4
Relative participation of the fraction (%)	17.1	41.4	46.9	42.9	41.8	31.2	24.6		40.9	42.1	30.9	32.9	40.8	48.0	37.6
Inflorescences															
Fresh weight (g/0.25 m²)		16.4	26.3	58.4	74.0	82.4	1.4		32.8	32.4			11.7		37.3
Absolute dry weight (g/0.25 m²)		10.0	16.0	33.6	47.3	48.0	1.1		21.8	17.2			6.8		22.4
Absolute dry matter (%)		61.2	60.8	57.5	63.9	58.3	76.1		66.4	53.1			57.8		62.1
Relative participation of the fraction (%)		1.2	1.9	10.5	11.4	4.1	0.9		5.2	3.0			0.6		3.6
Number of stalks per m²	36.0	40.0	96.0	32.0	56.0	56.0	20.0		44.0	28.0	44.0	36.0	44.0	16.0	42.2
Number of inflorescences per m²		12.0	32.0	24.0	36.0	44.0	8.0		32.0	24.0			16.0		17.5
Total weight for the plot (kg/m²)	1.5	2.2	3.5	1.3	1.7	4.6	0.5		1.7	2.3	2.9	2.1	5.5	1.7	2.4
Yields of above-ground phytomass (t/ha)	**14.8**	**22.2**	**35.2**	**12.9**	**16.6**	**46.3**	**4.5**		**16.9**	**22.8**	**29.5**	**20.5**	**55.4**	**17.3**	**24.2**
						2011									
Stems															
Fresh weight (g/0.25 m²)	619.1				353.7	454.1	239.7	269.7	212.0	661.0		591.7		620.7	446.9
Absolute dry weight (g/0.25 m²)	286.7				204.5	231.9	99.7	99.9	102.7	267.6		217.7		188.8	188.8
Absolute dry matter (%)	46.3				57.8	51.1	41.6	37.0	48.4	40.5		36.8		30.4	54.0
Relative participation of the fraction (%)	64.4				55.2	46.4	36.6	43.0	49.2	59.2		35.5		53.0	49.3
Leaves															
Fresh weight (g/0.25 m²)	395.5				320.1	471.4	282.1	224.7	211.7	381.7		545.7		472.7	367.3
Absolute dry weight (g/0.25 m²)	140.8				124.2	222.6	144.9	108.5	87.9	184.2		392.4		167.7	174.8
Absolute dry matter (%)	35.6				38.8	47.2	51.4	48.3	41.5	48.3		71.9		35.5	36.5
Relative participation of the fraction (%)	31.6				33.5	44.6	53.2	46.7	42.1	40.8		64.1		47.1	45.6
Inflorescences															
Fresh weight (g/0.25 m²)	29.0				68.0	77.1	36.7	33.0	27.0			4.3			30.6
Absolute dry weight (g/0.25 m²)	17.7				41.7	44.9	27.6	24.2	18.2			2.6			19.6
Absolute dry matter (%)	61.0				61.3	58.3	75.1	73.3	67.4			60.2			50.7
Relative participation of the fraction (%)	4.0				11.3	9.0	10.1	10.4	8.7			0.4			5.1
Number of stalks per m²	48.0				32.0	32.0	32.0	20.0	24.0	28.0		28.0		20.0	29.3
Number of inflorescences per m²	24.0				32.0	24.0	16.0	12.0	24.0			8.0			15.6
Total weight for the plot (kg/m²)	1.8				1.5	2.0	1.1	0.9	0.8	1.8		2.5		1.4	1.5
Yields of above-ground phytomass (t/ha)	**17.8**				**14.8**	**20.0**	**10.9**	**9.3**	**8.4**	**18.1**		**24.5**		**14.3**	**15.3**

Schoenoplectus lacustris Palla and etc. mention deserves the fact that, as a rule, species from the reed floor participate to a much lesser extent in the formation of its grass stand. Owing to the fact that reed coenoses have been studied in a relatively large region (the valley of the Danube between Archar and Srebarna), the total species diversity of these plant communities registers 53 higher plant species, which is quite impressive floristic richness (**Table 1**).

These were reed phytocoenoses formed in marshy places in the river valleys and in other open water bodies (Bardat et al., 2001). They are a major component to aquatic vegetation and of vegetation around the waterbodies, attached to the floor of the fresh-waterbasins. In many places, belts and patches mainly of Common Reed (*Phragmites australis*) have been formed, with the participation of rush (*Typha* sp.), bulrush (*Schoenoplectus lacustris*), high sedges (*Carex* sp.), and others in the process of shallowing out, drying and filling up of the various water bodies with plant remains. This slow natural process could be stepped up by anthropogenic activity. These facts contribute to the environmental and nature-protection importance of rush coenoses.

When these coenoses are formed in the river shallows or in the near-by shallow water bodies, the composition of reed communities is joined also by submerged or water floating species, such as *Ceratophyllum demersum*, *Lemna minor*, *Lemna trisulca*, *Myriophyllum spicatum*, frequently *Hydrocharis morsus-ranae*, as well as by some representatives of the sedges (genus *Carex*, *Schoenoplectus lacustris*) and grasses. Quite telling is the fact that *Ceratophyllum demersum* species figures in ten out of 17 descriptions altogether. The other species identified in the reed coenoses have much lower frequency of occurrence: usually between one and four to five times (**Tab. 2**).

There is a difference in species composition in the studied descriptions of reed communities, determined by the specific conditions of the biotope. A common trait is the very strong quantitative presence of the dominant species, which forms almost pure one-floor grass stands, where the projection cover of dominant species often reaches 85-90% and over. The reed floor is 3 m to 5 m high and even higher. Its characteristics (height and projection cover) determine very strongly the specific ecological conditions in these coenoses: temperature, humidity, light and air movement. The other species are mostly present on the periphery of these grass stands or in their thinned-out areas. Special mention deserves a very important factor for the floristic enrichment of these phytocoenoses, namely, the presence of residual water on the surface of the terrain occupied by them, where a second (and even third) floor could be formed of the species developing in it or on its surface (*Lemna minor*, *Myriophyllum spicatum*, *Ceratophyllum demersum* and others).

About the formed above-ground phytomass and its distribution, the obtained data have shown that the absolutely dry matter of the different fractions of reed above-ground phytomass exceed by half its fresh weight: 53-54% for the stems, 35-53% for the leaves and 50-60% for the inflorescences (**Tab. 3**). Therefore, the plants stems contain the greatest amounts of water, which is due to the fact that most conductive tissues, which carry out the water and assimilates needed for normal existence of the plant organism, are situated there.

The main part of the reed above-ground phytomass is formed by its stems: somewhere between 82.90% and 35.53%. Second comes the leaves fraction: from 64.05% to 24.60%. Relative participation of inflorescences does not exceed

Table 3. Average values of fractions from different parts of reeds for the two years of investigation

Fractions	Average values
Stems	
Fresh weight (g/0.25 m²)	597.64
Absolute dry weight (g/0.25 m²)	280.14
Absolute dry matter (%)	43.55
Relative participation of the fraction (%)	54.04
Leaves	
Fresh weight (g/0.25 m²)	401.86
Absolute dry weight (g/0.25 m²)	206.29
Absolute dry matter (%)	44.94
Relative participation of the fraction (%)	41.6
Inflorescences	
Fresh weight (g/0.25 m²)	33.93
Absolute dry weight (g/0.25 m²)	21.04
Absolute dry matter (%)	56.39
Relative participation of the fraction (%)	4.36
Number of stalks per m²	35.74
Number of inflorescences per m²	16.54
Total weight for the plot (kg/m²)	**1.98**
Yields of above-ground phytomass (t/ha)	**19.78**

11.40%, i.e. the reproductive organs of this species form less than one-twentieth of the plant above-ground phytomass (**Tab. 2**).

Data obtained from the samples cut in the field have permitted calculation of the stocks of above-ground phytomass of the surveyed reed communities. Apparently, the lowest stocks came from the sampling plot at Belene (Kaikusha Locality) – 4.53 t/ha, and the highest came from the sampling plot on Srebarna island – 55.36 t/ha (**Tab. 2**). Comparison of the stocks of above-ground phytomass of reed conenoses shows clearly higher data for 2010– 24.22 t/ha, against 15.33 t/ha in 2011. This is quite explicable, considering the fact that the vegetation season in 2011 was much drier than in the previous year.

Averaged results from the different sites during the two years of survey (**Tab. 3**) have shown the following:

■ somewhat above half of the above-ground phytomass was concentrated in the reed stems (54.04 %). Almost 42% of that mass was formed by the leaves, while the generative organs (inflorescences) contained less than 5% of the general amount of the phytomass. Further more, the surveyed reed coenoses formed a main floor with a very dense grass stand: on the average, almost 36 reed stalks grew per square meter, which prompted the conclusion that reed communities make relatively very good use of the ecotope conditions.

■ the **Table 3** also shows that nearly half (47%) of the reed stalks in the model plot did not develop inflorescences. This could be used as a proof of the importance of vegetative propagation of this plant species.

■ the average stocks of above-ground phytomass of the plant communities amount to 19.78 t/ha, or about 4.6 times less than the data (91.7 t/ha) published by Kochev & Yordanov (1981) from a survey of the primary biological production of reed associations in Bulgaria. The figures reported by Kochev & Yordanov (1981) were probably so high due to the fact that the authors had measured both green and dry mass in the reed floor and the latter comprised the plant substance formed during the previous vegetation season. According to Kochev & Yurukova (1984), reed communities in the Aldomir marsh form bioproduction to the tune of 36.7 t/ha, which is only twice higher than the present results.

The samples taken to determine the stocks of above-ground phytomass formed by the other plant species participating in the formation of reed coenoses have shown that their proportion of the above-ground phytomass varies between 0.49 t/ha and 4.41 t/ha,or on the average is1.46 t/ha (**Tab. 4**). Thus the total stocks of above-ground phytomass of the surveyed reed coenoses amount on the average to 21.24 t/ha.

Ecosystematically, besides being a major phytomass producer, reed communities also play an important part in the formation of local micro climate. Suitable micro climatic conditions predetermine a greater diversity of the faunistic component of these specific bio-geocoenoses: periphyton (mollusks, insects), ornithofauna, amphibians and reptiles, as well as fish stock, where there is water.

Table 4. Data for absolute dry weight of the accompanying species in reed communities measured in 2011

Sites	**Absolute dry weight** (g/0.25 m²)	**Absolute dry weight**(t/ha)
Orsoya 1	15.73	0.63
Orsoya 2	12.24	0.49
Lower Vit	16.93	0.68
Kaikusha	67.34	2.69
Kalimok	110.24	4.41
Garvan Marsh	16.53	0.66
Srebarna	16.16	0.65
Average	**36.45**	**1.46**

Conclusion

The total stocks of above-ground phytomass of the surveyed reed communities averaged 21.24 t/ha. Only about 8% of that amount was formed by the accompanying plant species.

The average stocks of above-ground phytomass of the plant communities accounted for 19.78 t/ha.

Little more than half of the above-ground phytomass was concentrated in the stems of the reeds (54.04%). About 40% of it was formed by the leaves, while less than 5% of the general phytomass amount was due to the inflorescences.

Nearly half of the reed stalks in a model plot did not develop inflorescences, which comes to prove the importance of vegetative propagation of this plant species.

Considering the fact that they are among the widest distributed components along the river valley and the greatest producer of phytomass among the other components of grassy vegetation in the river's

fluvial terrace, and also that reed massifs play a major part in the normal functioning and development of riparian ecosystems, it becomes clear that they are very important and determinant for the processes of mineralization of the produced phytomass and its depositing on the soil or floor of the water bodies.

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