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WATER AND RUSH PLANT ASSOCIATIONS OF THE BUG VALLEY OLD RIVER-BED (KRYŁÓW – KODEŃ SECTION) VIS-À-VIS THE HABITAT CONDITIONS

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Summary. In 2003, studies on habitat conditions and the distribution of water plant associations from the *Charetea*, *Lemnetea* and *Potametea* and rush plants associations from the *Phragmitetea* class commenced in 30 old river-beds of the Bug Valley (on border section Kryłów – Kodeń). The studies also covered the immediate vicinity of these old river beds (soil cover, plant cover, usage methods). In the water samples collected in 2004, the following parameters were determined: conductivity, pH together with the content of total phosphorus, total nitrogen, potassium, sodium, calcium, magnesium and ferrum. In the old river-beds studied, the presence of 17 water plant communities of the following classes: *Lemneta*, *Charetea*, *Potametea* and 16 rush plant communities of the *Phragmitetea* class, were noted. The plant associations identified showed the eutrophic character of the water in the old river-beds studied.

Key words: old river-beds, the Bug Valley, plant associations, habitat conditions

INTRODUCTION

Characteristic hydrographic elements of the Bug Valley are the meandering lakes, called old river-beds, river lakes or „bużyska". Most of these reservoirs are located in a zone with a periodical supply of flood water and change during periods of high water [Michalczyk *et al.* 2002]. In the old water-beds of the River Bug and in their surroundings, associations of water plants, rushes, riverside terophytes and periodically wet cavities, osier associations and alder swamp associations were formed together with riverside willow brakes and willow-poplar marshy meadows [Urban and Wójciak 1999, Urban and Wójciak 2002, 2003]. Water and rush plants occurring in habitats with specifically determined physical and chemical parameters of the water and bottom deposits, are especially interesting [Kłosowski 1992].

The aim of the present study was to identify the water and rush plant associations of selected old river-beds in the valley of the River Bug in the section between Kryłów and Kodeń against a background of habitat conditions, mainly the chemical compositions of the water in these old river-beds.

STUDY AREA, MATERIAL AND METHODS

In 2003, studies on the habitat conditions and distribution of water plant and rush associations were started in 30 old river-beds in the Bug Valley (border section Kryłów – Kodeń). These old river-beds differed in size, depth and the utilization of their surroundings. Reservoirs are located close to the following villages: Kryłów (Kr1, K22, Kr3), Husynne near Hrubieszów (Hs1), Starosiele (Sr), Dubienka (Db1, Db2), Uchańka (Uch), Husynne near Okopy (Hs2), Okopy Nowe (ON1, ON2), Hniszów (Hn), Wola Uhruska (WU1, WU2), Stulno (St1, St2), Wołczyny (Wł), Zbereże (Zb), Sobibór (Sb1, Sb2), Dołhobrody (Dh1, Dh2), Łydyny (Łd), Sławatycze (Sł1, Sł2), Liszna (Li), Nowosiółki (Nw1, Nw2), Jabłeczna (Jb1, Jb2) and Kodeń (Kd).

Phyto-sociologic studies were carried out in 2003 and in May 2004, using the generally recognized Braun-Blanquet method [1951]. Phyto-sociologic units were distinguished according to Matuszkiewicz [2001], Fijałkowski [1991] and Tomaszewicz [1979]. Table 1 lists the plant communities identified together with their percentage share in each of the old river-beds studied. A 5-degree scale was used in which 5 denotes the covering of the reservoirs surface area in 75 to 100%, 4 – from 50 to 75%, 3 – from 25 to 50%, 2 – from 10 to 25% and 1 – up to 10%. The present studies also covered the vicinity of the old river-beds (soil land plant cover and utilization). The results of the studies on the chemism of the soil cover in the vicinity of the reservoirs and the deposits on the bottom of these reservoirs will be presented in another review.

Water samples were taken from the old river-beds studied. The following parameters were determined in the samples collected: pH, conductivity, content of total phosphorus and nitrogen according to the methods described by Hermanowicz *et al.* [1999]. Macroelements such as: Ca, K and Na were determined using flame emission spectrometry (on a Plapho 40 photometer), the content of Mg and Fe was determined by absorption atomic spectrometry (ASA).

RESULTS AND DISCUSSION

The immediate vicinity of the old river-beds studied was varied. Reservoirs Kr1, Kr2, Db1, Db1, Wł, Sb1, Dh2, and also partially Sł1, Li, Jb1 were located in the vicinity of meadows of the *Molinio-Arrhenatheretea* class. Around the old river-beds Hn, Sb1 and partially also Sb2, Dh1, Sł2, Jb2 and Kd there occurred alder swamps of the class of *Alnetea glutinosae* and willow thicket – *Alnetea glutinosae* together with willow and poplar swampy meadows of the *Salicetea purpureae* class. On the banks of the Kr3 (West), Hs1 (North), Uch (South), ON1 (North), ON2 (South), WU1 and WU2 (West), St1 (South), Zb (West), Dh1 (West), Łd (around), Nw2 (East), Jb2 (East) and Kd (East) reservoirs there were buildings and small waste disposal fields covered with rudelana plants. The St2, Sł1 i Sł, Li, Jb1 and Jb2 old river-beds were located close to asphalt roads. Two of the reservoirs studied (Sr and WU2) were used as swimming pools in part.

Soil cover in the vicinity of most of the old river-beds was alluvial. Black soils also occupied some of the surface. Podzolic-earth soils were to be found on the western banks of St and WU2 old river-beds as well as on the northern banks of Db1, Sł1 old river-beds and the eastern banks of Kd old river-bed.

Table 1. List of the water and rush plant associations in the 30 old river-beds of the Bug Valley (on the border section Kryłów – Kodeń)
Tabela 1. Zbiorowiska wodne i szuwarowe w 30 starorzeczach doliny Bugu (na granicy Kryłów – Kodeń)

Association Zbiorowisko	Old river beds – Starorzecza																																
	Kr1	Kr2	Kr3	Hs1	Sr	Db1	Db2	Uch	Hs2	ON1	ON2	Hn	WU1	WU2	St1	St2	Wl	Zb	Sb1	Sb2	Dh1	Ły	Dh2	Sł1	Sł2	Li	Nw1	Nw2	Jb1	Jb2	Kd
Charetum vulgaris	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lemno-Spirodeletum	4	1	1	1	3	3	5	3	3	5	3	5	3	1	4	5	3	3	1	2	3	5	3	1	4	4	4	4	4	4	4	4	4
Wolffietum arrhizae	.	.	.	.	.	.	1	.	.	.	.	1	1	.	2	2	.	.	.	.	1	.	.	.	.	2	3	3	2	4	.	.
Lemnetum gibbae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	.	.
Ranunculetum circinati	.	.	.	.	2	.	.	.	.	.	.	.	3	1	.	.	.	.	1	.	.	.	.	2	.	.	.	.	.	.	.	.
Elodeetum canadensis	1	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ceratophylletum demersi	2	1	.	1	2	2	2	2	.	3	.	3	2	2	.	.	.	1	.	1	1	2	2	.	2	2	2	3	3	4	.	.
Myriophylletum spicati	.	.	.	.	.	.	.	2	.	.	.	.	.	1	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Potametum lucentis	.	2	.	.	.	2	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potametum crispi	1	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Potametum pectinati	2	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hydrocharitetum morsus-ranae	2	2	.	.	1	1	1	1	.	.	.	1	2	1	.	.	.	.	.	.	1	.	1	1	.	1	1	1	.	.	1	.
Stratiotetum aloidis	1	2	.	.	1	2	.	.	.	.	.	4	1	.	.	.	.	.	.	.	1	.	2	1	.	2	4	3	1	3	1	.
Potametum natanis	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nupharo-Nymphaetum albae	2	.	.	.	3	3	2	2	.	.	1	1	2	2	.	.	.	.	.	1	.	1	.	1	.	1	.	.	3	2	1	.
Hottonietum palustris	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scirpetum lacustris	1	2	.	.	1	2	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.
Typhetum angustifoliae	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	4	.	.	.	.	.
Sagittario-Sparganietum emersi	2	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Sparganietum erecti	.	.	.	.	2	1	1	.	.	.	.	1	.	.	.	.	.	.	1	.	1	1	.	.	.	.	1	1	.	.	.	.
Eleocharitetum palustris	.	1	.	.	1	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Equisetum fluviatile	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phragmitetum australis	.	.	.	.	2	2	2	.	.	.	2	2	1	1	.	.	2	.	.	.	.	.	.	.	2	3	.	.	.	.	.	.
Typhetum latifoliae	2	1	1	.	1	.	1	.	.	2	1	3	.	.	2	.	.	.	.	.	2	1	2	1	.	1	2	.	.	.	.	.
Acoretum calami	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Oenantho-Rorippetum	2	4	1	3	1	.	.	.	2	2	2	1	1	.	2	.	1	.	.	2	.	2	1	.	2	1	.	.	1	1	.	.
Glycerietum maximae	1	2	.	1	2	.	2	1	3	2	2	.	3	2	2	.	2	.	.	1	2	3	2	.	2	.	3	2	2	2	3	.
Scirpetum maritimi	1	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cicuto-Caricetum pseudocyperi	.	.	.	.	1	.	1	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Iridetum pseudacori	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Caricetum ripariae	.	1	3	1	2	1	1	1	.	1	1	1	2	1	1	.	1	2	2	2	.	1	1	1	1	1	1	.	.	1	1	.
Phalaridetum arundinaceae	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.

1 – the covering of the reservoir surface area in 10%, 2 – 10-25%, 3 – 25-50%, 4 – 50-75%, 5 – 75-100%
1 – pokrycie powierzchni rezerwatu w 10%

Table 2. Differention of pH, conductivity, and chemical composition in surface waters in 30 old river-beds of the Bug Valley (on border section Kryłów – Kodeń)

Tabela 2. Zróżnicowanie pH, przewodnictwa i składu chemicznego wód powierzchniowych w 30 starorzeczach doliny Bugu (na granicy Kryłów – Kodeń)

Old river-bed Starorzecza	pH	Conductivity Przewodnictwo $\mu S \cdot cm^{-1}$	Content in $mg \cdot dm^{-3}$ Zawartość w $mg \cdot dm^{-3}$						
			P	N	K	Na	Ca	Mg	Fe
Kryłów – Kr 1	7.65	594	0.17	3.6	6.6	31.5	115.3	13.6	0.52
Kryłów – Kr2	7.95	496	0.14	3.2	2.1	28.2	86.6	9.8	0.57
Kryłów – Kr3	7.48	685	0.02	4.0	20.4	43.1	84.1	13.6	0.85
Husynne – Hs1	7.65	594	0.13	3.0	1.5	17.5	102.0	16.7	0.85
Starosiele – Sr	7.75	487	0.17	5.4	2.4	17.7	79.6	7.9	0.35
Dubienka – Db1	7.97	572	0.24	4.8	2.5	21.0	88.0	8.6	0.52
Dubienka – Db2	7.55	691	0.19	3.6	1.9	13.4	128.9	10.4	0.52
Uchańka – Uch	8.56	462	0.35	6.2	2.2	15.5	86.3	5.8	0.57
Husynne – HS2	7.46	490	0.58	5.8	0.5	11.4	108.8	4.9	0.68
Okopy Nowe ON1	7.21	893	0.60	4.2	24.3	45.5	115.9	10.5	0.52
Okopy Nowe ON2	7.62	724	0.24	6.2	6.8	33.4	111.0	9.7	0.52
Hniszów – Hn	7.41	501	0.35	3.6	1.4	17.2	108.6	11.0	0.95
Hniszów – Hn	7.29	493	0.27	4.0	1.6	18.2	117.7	11.2	0.52
Wola Uhruska – WU1	7.40	497	0.29	3.0	1.9	13.7	134.3	7.6	0.95
Wola Uhruska – WU2	7.64	486	0.42	2.2	2.1	15.5	121.9	7.5	0.52
Stulno – St1	7.73	644	0.29	1.6	4.7	30.6	121.2	8.8	0.37
Stulno – St2	7.28	517	0.38	4.6	2.1	20.0	109.6	6.5	0.57
Wołczyny – Wł	7.25	489	0.80	3.2	1.5	17.8	127.3	5.6	0.75
Zbereże- Zb	7.23	242	0.39	4.0	6.6	25.2	41.9	3.2	0.85
Sobibór – Sb1	7.34	351	1.13	2.4	4.5	15.7	65.2	10.0	0.75
Sobibór – Sb2	7.37	642	0.41	2.8	2.1	15.4	139.4	12.2	0.75
Dołhobrody – Dł1	7.14	263	1.14	4.6	1.1	12.0	58.4	5.3	0.85
Łydyny – Ły	7.41	565	0.57	7.2	9.8	21.4	118.4	11.2	0.57
Dołhobrody – Dł2	7.30	329	0.24	7.0	2.7	13.2	76.7	6.9	0.85
Sławatycze – Sł1	7.70	379	0.23	5.0	2.7	15.2	82.0	11.7	0.57
Sławatycze – Sl2	7.48	967	0.19	4.6	4.4	70.7	142.7	12.2	0.57
Liszna – Li	7.29	388	0.63	2.8	1.4	20.2	80.4	6.9	0.52
Nowosiółki – Nw1	7.26	380	0.70	7.0	1.8	16.1	67.1	7.6	0.57
Nowosiółki – Nw2	7.22	386	0.46	4.8	1.9	16.1	67.3	7.9	0.57
Jabłeczna – Jb1	7.53	566	0.73	3.8	4.4	31.8	101.4	11.7	0.68
Jabłeczna – Jb2	7.31	348	1.04	5.2	10.4	17.2	52.6	7.6	0.52
Kodeń – Kd	7.41	374	0.41	7.2	1.2	10.1	69.7	8.3	0.57
Kodeń – Kd	7.19	365	0.38	6.8	1.2	9.8	67.5	6.5	0.52

Thirty-three communities (17 communities of water plants and 16 communities of rush plants) were identified in the reservoirs studied. In all the old river-beds, there were water plant communities of the *Lemnetea minoris* class (Tab. 1) such as: *Lemno-Spirodeletum polyrhizae* (in all old river water-beds studied), *Wolffietum arrhizae*

(11 old river-beds) and *Lemnetum gibbae* (8 old river-beds). In the small old river-beds (Kr1, Db2, ON1, IIn, Hs2, St1 i St2, Ld, Sl2, Li, Nw1, Jb1 i Jb2), the above phytocenoses covered almost the entire water surface of the water. In the larger reservoirs connected to the Bug River (e.g.: Kr3, WU2), these (phytocenoses) occurred in the form of small patches among the rushes. Communities of *Wolffietum arrhizae* and *Lemnetum gibbae* [Tomaszewicz 1979, Tomaszewicz and Kłosowski 1985, Fijałkowski 1991, Ciecierska 2002, Urban and Wójciak 2002, 2003] which are rare in the Lublin Region and Poland are worth special attention. These latter phytocenoses in the Bug River are connected with quiet and shallow old river-beds with organic substrates with water depths from a few centimetres to about 2 m (St1 i St2, Li, Nw1 and Nw2, Jb1 and Jb2).

It is worth noting that there were patches of phytocenoses of the *Charetea* class in which *Chara vulgaris* was the predominant species in two old river-beds (Uch i Sr).

The *Potametea* class was represented by 12 communities. The presence of *Ceratophylletum demersi* phytocenosis was noted in 22 old river-beds. In the largest of these meandering lakes, communities of *Nupharo-Nymphaeetum albae* with the predominant *Nuphar lutea* or *Nymphaea alba* were common. In the shallow old river-beds (up to 1 m water depth) sheltered from the and or in quiet bays of the larger reservoirs, communities of *Stratiotetum aloidis* (15 old river-beds) and *Hydrocharitetum morsus-ranae* (16 old river-beds) and *Ranunculetum circinati* (5 old river-beds) were formed. In a few old river-beds only small patches of *Potametum lucentis*, *P. crispi* and *Myriophylletum spicati* were found. The rarest were the communities of *Elodeetum canadensis* (Kr1) and *Hottonietum palustris* (WU1).

The shallower, old river-beds and silt banks of the deeper reservoirs were covered by rushes of the *Phragmitetea* class. The most frequently encountered communities were those of: *Glycerietum maximae* and *Caricetum rivariae* (23 old river-beds), *Oenantho-Rorippetum* (18 old river-beds) and *Typhetum latifoliae* (15 old river-beds). The phytocenoses of *Phragmitetum australis* and *Typhetum angustifoliae* were less frequent. In two of the old river-beds studied (Kr1, Hs1) patches of *Scirpetum maritimi* – a community which is rare in the Lublin Region [Fijałkowski and Chojnacka-Fijałkowska 1990] but quite frequently encountered in the Bug River Valley [Urban and Wójciak 1999, 2003] – were noted. Sporadically, there occurred communities of *Equisetum fluviatile* (Db2), *Thelypteridi-Phragmitetum* (Sr) and *Acoretum calami* (Zb).

The old river-beds Kr1 and WU1 (15 communities in each) varied widely in their water and rush associations, while the lowest was to be found in the Hs1, St2 (3 communities in each).

The studies so-far conducted showed that pleustonic plants formed a big group and occurred in all old river-beds. Plants from this group are connected with eutrophic reservoirs which are rich in nutrients [Kłosowski 1992, Radwan *et al.* 1998, Ciecierska 2002, Radwan 2003]. Elodeid plant communities were less numerous in the old river-beds studied; however, only in five of the old river-beds discussed (i.e.: Kr3, IIs1, ON2, Wł, Sb1) they did not occur. According to Tomaszewicz and Kłosowski [1985], the phytocenoses from this sphere are connected to eutrophic and polytrophic waters. The communities of *Nupharo-Nymphaetum* and *Potametum natantis* (Tab. 1) formed the largest areas (in a few of the old river-beds studied) out of the nympheid sphere. Proper rushes and sedge rushes were best developed in shallow and silted reservoirs.

The preliminary chemical analysis of water samples collected from 24 old river-beds in August 2003 showed that these waters were characterised by a basic or neutral reaction, and their total phosphorus content ranged from 0.09 to 0.59 mg · dm^{-3}; the calcium content ranged from 33.7 to 105.5 mg · dm^{-3}, magnesium from 9.0 to 28.4 mg · dm^{-3}, potassium from 3.6 to 16.9 mg · dm^{-3}, sodium from 3.5 to 41.9 mg · dm^{-3}, ferrum from 0.12 to 0.67 mg · dm^{-3}.

The results of the water samples collected in May 2004 from all the old river-beds studied showed that these waters were characterised by electrolytic conductivity from 242 to 967 μS · cm^{-1}, which allows them to be classified as water reservoirs rich in dissolved ions (Tab. 2). The content of total phosphorus ranged from 0.02 to 1.14 mg · dm^{-3}. The highest P concentration level was noted in the waters of the following old river-beds: Wł, Sb1, Dh1, Nw1, Jb2. Taking into consideration the total phosphorus content (above 0.100 mg · dm^{-3}) regarded as the main factor eutrophicating the reservoir [Wojciechowska and Zykubek 1999, Chełmicki 2002], almost all old river-beds studied can be classed as hypertrophic reservoirs [Kajak 1979]. According to Woyciechowski and Dojlido [2003] the waters of the Bug River are strongly eutrophicated, and the total phosphorus concentration in them exceeds valid standards in this respect (especially in the section from Kryłów to Dorohusk). The total nitrogen content in the old river-beds studied ranged from 1.6 to 7.2 mg · dm^{-3}. The river waters of the Bug (in the Kryłów to Terespol section) studied in 2001 [Woyciechowska and Dojlido 2003] were characterised by a lower N concentration ranging from 3.04 to 3.92 mg · dm^{-3}. The lowest N content was noted in those reservoirs located in the direct vicinity of buildings and gardens or arable land. (Uch, Hs1, ON2, Ld, Nw1, Kd). Studies by other authors showed similar relations [Radwan *et al.* 1998, Ciecierska 2002]. According to Radwan *et al.* [1998], mass tourism and recreation, together with the summer houses located there, influence the level of biogens in some lakes of the Łęczyńsko-Włodawski Lake District.

The content of basic macro-elements varied. The potassium content ranged from 0.5 to 24.3 mg · dm^{-3}, sodium from 9.8 to 70.7 mg · dm^{-3}, calcium from 41.9 to 142.7 mg · dm^{-3}, magnesium from 3,25 to 16,70 mg · dm^{-3} and ferrum from 0,37 to 0,95 mg · dm^{-3}.

CONCLUSIONS

In the studied old river-beds the presence of 17 water plant communities of the following classes: *Lemneta*, *Charetea*, *Potametea* and 16 rush plant communities of the *Phragmitetea* class were noted. In July and August of 2004, these plants covered all the surface area in most reservoirs. In shallow and silted old river-beds, communities of *Lemnetea* and *Potametea* were predominant.

The identified plant associations showed eutrophic character of the water in the old river-beds studied.

The waters of the old river-beds studied were characterised by high concentrations of phosphorus and total nitrogen as well as calcium and sodium.

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ZRÓŻNICOWANIE ZBIOROWISK WODNYCH I SZUWAROWYCH STARORZECZY DOLINY BUGU (ODCINEK KRYŁÓW – KODEŃ) NA TLE WARUNKÓW SIEDLISKOWYCH

Streszczenie. W 2003 r. rozpoczęto badania warunków siedliskowych i rozmieszczenia zbiorowisk wodnych z klas: *Charetea*, *Lemnetea* i *Potametea* i szuwarowych z klasy *Phragmitetea* w 30 starorzeczach doliny Bugu (na odcinku granicznym Kryłów – Kodeń). Badaniami objęto także otoczenie tych starorzeczy (pokrywa glebowa, szata roślinna, sposób użytkowania). W próbkach wody oznaczono pH oraz zawartość wapnia, magnezu, potasu, sodu, żelaza i fosforu. W badanych starorzeczach stwierdzono występowanie 17 zespołów roślinności wodnej z klas: *Charetea*, *Lemnetea* i *Potametea* i 16 z klasy *Phragmitetea*. Zidentyfikowane zbiorowiska roślinne wskazują na eutroficzny charakter wód badanych starorzeczy.

Słowa kluczowe: starorzecza, dolina Bugu, zbiorowiska roślinne, warunki siedliskowe