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Differentiation of rush communities of mid-field ponds in the western part of Drawskie Lakeland

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Abstract. The objects of the research were 30 mid-field ponds situated in the western part of Drawskie Lakeland. A synthetic table shows 153 relevés representing 12 rush associations. Totally, within the studied water ponds, 23 plant communities were distinguished, including 12 rush associations. These are: *Sparganietum erecti*, *Eleocharitetum palustris*, *Phragmitetum australis*, *Typhetum latifoliae*, *Acoretum calami*, *Oenantho-Rorippetum*, *Cicuto-Caricetum pseudocyperi*, *Iridetum pseudacori*, *Caricetum acutiformis*, *Caricetum gracilis*, *Caricetum vesicariae* and *Sparganio-Glycerietum fluitansis*. Phytosociological constancy of the species forming the structure of 12 recognized plant communities phytocoenoses: *Caricetum gracilis* (75), *Caricetum vesicariae* (71) and *Typhetum latifoliae* (63 taxa) are floristically the richest, whereas *Sparganietum erecti* (38) and *Cicuto-Caricetum pseudocyperi* (41 species) are the poorest. The species characteristic of the *Phragmitetea* and *Molinio-Arrhenatheretea* classes are dominant among them. Rush associations of the *Magnocaricion* alliance and contributions of the species from both classes are approximate. The *Magnocaricion* rushes are in contact with communities of the *Phragmition* alliance and with communities of moist meadows of the *Molinietalia* order, hence the contribution of species to them from both the classes. In phytocoenoses of the *Phragmition* alliance there are fewer species of the *Molinio-Arrhenatheretea* class and slightly more species of the *Potametea* class than in the communities of the *Magnocaricion* alliance. The analysis of similarity of the communities was carried by the UPGMA method using Euclidean distances on the basis of phytosociological constancy of species with the application of the STATISTICA PL packet (1984–1985). Coefficients of similarity of the associations were calculated by means of the Sörensena method and the obtained results were shown in the Czekanowski diagram.

K e y w o r d s**:** plant communities, rush communities, mid-field ponds, Drawskie Lakeland

1. Introduction

Characteristic features of Drawskie Lakeland are large natural and landscape values. One of the early post glacial landscape features is the presence of ponds, picturesquely situated among fields and forests. These ecosystems play imortant ecological functions in the landscape, in the agricultural landscape in particular (Olaczek, 1990; Sierka, 1997; Kochanowska *et al*., 1997; Koc *et al*., 2001). Despite that, they are exposed to

degradation, first of all as a result of agricultural intensification (KOCHANOWSKA *et al*., 1996; KALETTKA and RUDAT, 1997; KOCHANOWSKA and RANISZEWSKA, 1999). The problem of disappearance of ponds was the objective of numerous research works (BOOTHBY *et al*., 1996; PACZUSKA and PACZUSKI, 1997; LUTHARD and DREGER, 1996; SIBBETT, 1999; BOSIACKA and PIEŃKOWSKI, 2003; 2004; PIEŃKOWSKI, 1996; 2000; 2003; 2004; 2008; PIEŃKOWSKI *et al*., 2004). One of the activities leading to preservation of water ponds is reduction in the infow of biogenes to bodies of water (BACIECZKO 1996, KOC and SZYPEREK, 2001). PIEŃKOWSKI (2002) remarks that the least number of the ponds which vanished refers to the ponds surrounded by trees. To some extent it is possible by preservation or introduction of protective vegetation around the bodies of water (RYSZKOWSKI *et al*., 1994; ARCZYŃSKA-CHUDY *et al*., 1996). The species composition and the width of littoral vegetation belt determined the reduction level of biogenes flowing into the water of a pond. Large abilities to accumulate nutrients are characteristic features of rush communities. Rushes of the *Phragmition* alliance are mainly found in the intermediate zone between communities of hydrophytes of the *Potametea* class and rushes of the *Magnocaricion* alliance. Rushes of the *Magnocaricion* alliance are situated closer to the waterside line, less frequenly and much shorter flooded than those of the *Phragmition* alliance habitats. From one side they are adjacent to communities of the *Phragmition* alliance, sometimes also to water communities of the *Potametea* class, and from the other side, to communities from low peatland and transitional peatland (*Scheuchzerio-Caricetea nigrae*) or to communities of meadows (*Molinietalia*) or floodplain grasses (*Agropyro-Rumicion crispi*), they are often adjacent to alder communiries (*Alnetea glutinosae*) (MATUSZKIEWICZ, 2007).

The aim of the present study was to depict synthetically communities of rushes found within the midfield water ponds in the western part of Drawskie Lakeland.

2. Materials and methods

The objects of the research were 30 mid-field ponds situated in the western part of Drawskie Lakeland. Field investigations were carried out in the vegetation season in the years 1995–1999. They consisted in making 30 floristic registers and taking 164 phytosociological relevés using the Braun-Blanquet method in the areas of 20–50 m^2. A synthetic table shows 153 relevés representing 12 rush associations. The analysis of similarity of the communities was carried by the UPGMA method using Euclidean distances on the basis of phytosociological constancy of species with the application of the STATISTICA PL packet (1984–1985). Coefficients of similarity of the associations were calculated by means of the Sörensena method and the obtained results were shown in the Czekanowski diagram (DZWONKO, 2007).

The names of species are given according to MIREK *et al*. (2002). Phytosociological affiliation of taxons was determined on the basis of MATUSZKIEWICZ'S description (2007). The degree of threat of the plant communities was defined according to RATYŃSKA (1997) and BRZEG and WOJTERSKA (1996).

3. Results

Totally, within the studied water ponds, 23 plant communities were distinguished, including 12 rush associations.

Class: *Phragmitetea* R. Tx. et Prsg 1942
Order: *Phragmitetalia* Koch 1926
Alliance: *Phragmition* Koch 1926
Association *Sparganietum erecti* Roll 1938
Association *Eleocharitetum palustris* Šennikov 1919
Association *Phragmitetum australis* (Gams 1927) Schmale 1939
Association *Typhetum latifoliae* Soó 1927
Association *Acoretum calami* Kobendza 1948
Association *Oenanthe-Rorippetum* Lohm. 1950
Alliance *Magnocaricion* Koch 1926
Association *Cicuto-Caricetum pseudocyperi* Boer et. Siss. in Boer 1942
Association *Iridetum pseudacori* Eggler 1933
Association *Caricetum acutiformis* Sauer 1937
Association *Caricetum gracilis* (Graebn. et Hueck 1931) R. Tx. 1937
Association *Caricetum vesicariae* Br.-Bl. et Denis 1926
Alliance *Sparganio-Glycerion fluitantis* Br.-Bl. et Siss. in Boer 1942
Association *Sparganio-Glycerietum fluitantis* Br.-Bl. 1925

Taking phytosociological constancy of the species forming the structure of 12 recognized plant communities phytocoenoses: *Caricetum gracilis* (75), *Caricetum vesicariae* (71) and *Typhetum latifoliae* (63 taxa) are floristically the richest, whereas *Sparganietum erecti* (38) and *Cicuto-Caricetum pseudocyperi* (41 species) are the poorest. The species characteristic of the *Phragmitetea* and *Molinio-Arrhenatheretea*. Classes are dominant among them. In the rush associations of the *Magnocaricion* alliance the contribution of the species from both classes is approximate. The *Magnocaricion* rushes are in contact with communities of the *Phragmition* alliance and with communities of moist meadows of the *Molinietalia* order, hence the contribution of species to them from both the classes. In phytocoenoses of the *Phragmition* alliance there are fewer species of the *Molinio-Arrhenatheretea* class and slightly more species of the *Potametea* class than in the communities of the *Magnocaricion* alliance (Tab. 1). Into consideration, three essential concentrations of associations can be identified in the dendrogram (Fig. 1). The first group consists of the communities from the *Magnocaricion* alliance within the range of which the most floristically approximate are the following associations: *Caricetum vesicariae*, *Iridetum pseudacori* and *Sparganio-Glycerietum fluitantis* – the latter one from the *Sparganio-Glycerion fluitantis* alliance. The second group of associations: *Typhetum latifoliae*, *Phragmitetum australis* and *Sparganietum erecti* is characterised by a larger floristic distinction as compared to the group of communities previously mentioned. In the dendrogram, phytocoenoses of this concentration show larger Euclidean distances than those in the first group. This proves their floristic distinctness. To this group belong also the associations of *Acoretum calami* and *Oenantho-Rorippetum*, from the *Phragmition* alliance, which show a much stronger mutual floristic similarity. By their species composi-

Table 1. The number of species of the characteristic phytosociological classes within the range of rush communities

Associations and alliance / Classes	*Magnocaricion*					*Phragmition*						*S**
	Caricetum gracilis	*Caricetum vesicariae*	*Caricetum acutiformis*	*Iridetum pseudacori*	*Cicuto--Caricetum pseudocyperi*	*Typhetum latifoliae*	*Phragmitetum australis*	*Acoretum calami*	*Oenantho-Rorippetum*	*Sparganietum erecti*	*Eleocharitetum palustris*	*Sparganio-Glycerietum fluitantis*
ChCl., O. *Phragmitetea, Phragmitetalia*	22	22	15	17	18	24	20	16	21	20	18	15
ChCl. *Molinio-Arrhenatheretea*	28	28	13	15	9	15	10	7	11	4	10	17
ChCl. *Scheuchzerio-Caricetea nigrae*	3	5	3	4	3	4	4	2	3	2	4	6
ChCl.,O. *Potametea, Potametalia*	4	2	0	2	4	4	6	4	4	4	5	2
ChCl. *Alnetea glutinosae*	3	4	4	3	2	4	3	2	3	2	3	3
ChCl. *Lemnetea minoris*	3	1	3	2	3	3	3	2	1	3	3	3
ChCl. *Artemisietea vulgaris*	4	5	3	0	1	3	5	5	4	1	2	3
ChCl. *Bidentetea tripartiti*	3	0	0	3	0	2	3	4	4	0	2	4
ChCl. *Isoëto-Nanojuncetea*	0	0	0	1	0	0	0	2	0	0	0	0
ChCl. *Stellarietea mediae*	0	0	0	0	0	0	0	1	1	0	0	1
Accompanying species	5	4	2	3	1	4	2	3	3	2	2	3
Total	75	71	43	50	41	63	56	48	55	38	49	57

S Sparganio-Glycerion fluitantis.*

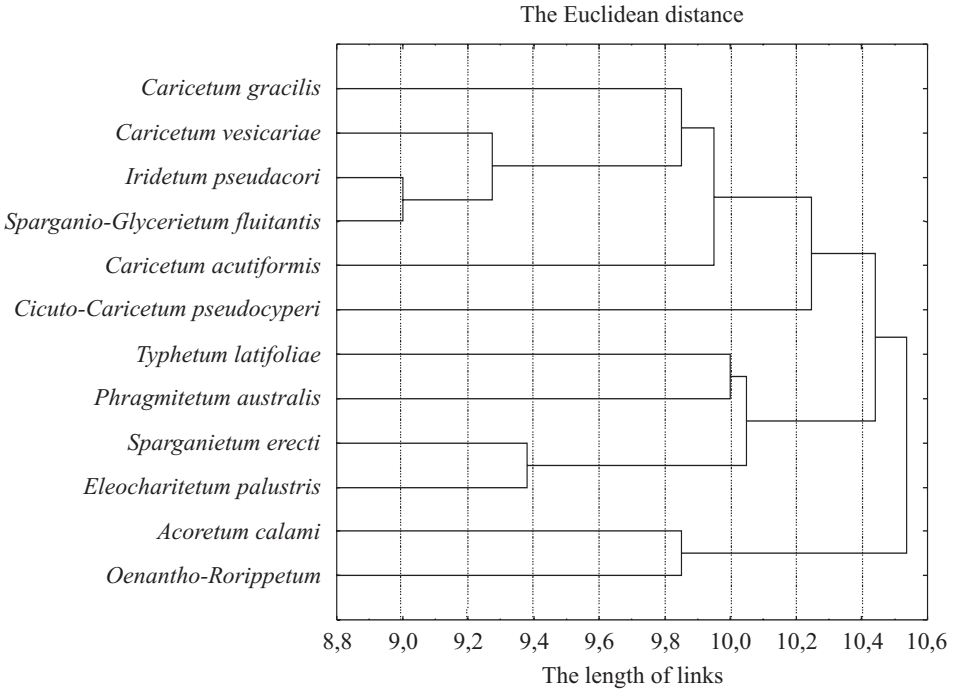

Fig. 1. The dendrogram of similarity of the plant associations

tion, they also resemble the associations of the second concentration, but the distances of Euclidean links between them in the dendrogram are larger. A mutual floristic similarity of the recognized communities is shown in the Czekanowski diagram (Fig. 2). In which two essential concentrations of associations of the largest mutual similarity can be identified. One group is composed of the community from the *Magnocaricion* alliance (values of the coefficients of similarity of most of the associations vary from 65 to 74%). They show a smaller similarity (from 45 to 64%) to the communities from the *Phragmition* alliance. Whereas associations of this alliance are characterised by a large mutual similarity (from 64 to 75%). Associations of rushes of the *Phragmition* alliance: *Iridetum pseudacori*, *Oenantho-Rorippetum* and *Typhetum latifoliae* also show a larger floristic similarity to associations of the *Magnocaricion* alliance, whereas the remaining associations of the *Phragmition* alliance are characterised by a smaller similarity to them.

Communities of the *Magnocaricion* alliance are separated from phytocoenoses of the *Phragmition* alliance by the association of *Sparganio-Glycerietum fluitantis*. This association shows a larger floristic similarity to communities of the *Magnocaricion* alliance (Fig. 2) These are low grass rushes with a contribution of numerous pernnial dicotyledonous plants, generally with no contribution of *Phragmites australis* (Tab. 2). The *Cicuto-Caricetum pseudocyperi* community is shown in the last column of the recognized communities (Fig. 2), despite the fact that it is the representative of the *Magnoca-*

Associations	*Caricetum acutiformis*	*Caricetum vesicariae*	*Caricetum gracilis*	*Sparganio-Glycerietum fluitantis*	*Iridetum pseudacori*	*Oenantho-Rorippetum*	*Typhetum latifoliae*	*Phragmitetum australis*	*Eleocharitetum palustris*	*Sparganietum erecti*	*Acoretum calami*	*Cicuto-Caricetum pseudocyperi*
Caricetum acutiformis		64	62	58	58	57	68	63	53	59	51	57
Caricetum vesicariae	64		72	61	65	66	69	63	55	52	56	55
Caricetum gracilis	62	72		66	65	71	70	63	59	59	59	63
Sparganio-Glycerietum fluitantis	58	61	66		84	68	64	60	63	55	67	57
Iridetum pseudacori	58	65	65	84		75	69	70	70	66	70	66
Oenantho-Rorippetum	57	66	71	68	75		68	68	74	65	74	63
Typhetum latifoliae	68	69	70	64	69	68		72	68	71	61	65
Phragmitetum australis	63	63	63	60	70	68	72		79	66	67	66
Eleocharitetum palustris	53	55	59	63	70	74	68	79		70	69	67
Sparganietum erecti	59	52	59	55	66	65	71	66	70		65	73
Acoretum calami	51	56	59	67	70	74	61	67	69	65		58
Cicuto-Caricetum pseudocyperi	57	55	63	57	66	63	65	66	67	73	58	

45–54% 55–64% 65–74% 75–84%

Fig. 2. The Czekanowski diagram of similarity of the plant associations

ricion alliance. It shows a larger floristic similarity to associations of the *Phragmition* alliance than *Magnocaricion*. These phytocoenoses are often found on small surfaces, in small mesothropic and eurothropic bodies of water of changeable water level (MATUSZKIEWICZ, 2007). Hence, probably its larger floristic similarity to communities of the *Phragmition* alliance. The floristic differentiation of associations of both the alliances is confirmed by their separate concentration in the dendrogram (Fig. 1).

Using the description worked out by SZOSZKIEWICZ and ŁAWNICZAK (2002) the standard deviation of the number of species in the phytosociological releves of individual associations was calculated (Tab. 3). The largest deviation within the *Magnocaricion* association was recorded in the case of Caricetum vesicariae, and the smallest for *Cicuto-*

-Caricetum pseudocyperi, whereas within the association of *Phragmition* the largest deviation, and thus the largest diversity was characteristic of *Typhetum latifoliae*, and the smallest – was characteristic of *Sparganietum erecti*.

In the *Caricetum gracilis* association two variants were distinguished. The typical one – which is characterised by a slightly more numerous contribution of species of the *Phragmitetea* class and its lower syntaxons. This variant occurs on sites of the whole year stagnation of water or its periodic flow. The variant with *Phalaris arundinacea* is distinguished by the presence of reed canary grass (*Phalaris arundinacea*) at the IV degree of constancy. The variant with *Filipendula ulmaria* is characterised by the considerable presence of plant species of meadow communities. It settles in habitats that are least favourable as regards moisture.

The patches of *Caricetum vesicariae* – phytocoenoses are characterised by a significant differentiation of the number of species. The poorest patches as regards the species have 9 taxons. They are rich floristically (more than 9 species – maximum 27, on average 16). Altogether in the association 71 species were found to occur (Tab. 2). Numerous is the *Phragmitetea* class – 22 species (Tab. 1). In the *Molinio-Arrhenatheretea* class and its lower syntaxons, 28 species occurred in the discussed association. The typical variant and the moss variant on sites of a smaller moisture content were distinguished.

The *Caricetum acutiformis* forms dense patches of different quantity, depending on the conditions of the biotope settled. Phytocoenoses of the association are floristically rather poor. On average there are 12 taxons in the relevé. Altogether, 43 species were recorded in the community. The *Caricetum acutiformis* association is mainly situated around larger water ponds. This community is very expansive. It displaces phytocoenoses of *Phragmition* from shallowed sites. Whereas, it itself is supplanted by the patches of *Caricetum gracilis* in more terrestrialised habitats or it gradually changes into *Caricion lasiocarpae*.

The *Iridetum pseudacori* association creates patches of small surfaces, in shallow astatic bodies of water. The mean number of species in its patches equalled 12. Altogether, in the discussed community 50 taxons of plants were recorded. The *Phragmitetea* class and its lower syntaxons were represented by 17 species, two of which, *Carex vesicaria* and *Galium palustre* reached a large 4th degree of constancy. In the association the water variant with *Lemna minor* and a more frequent contribution of characteristic species of the *Magnocaricion* alliance and the specific variant were distinguished. In both variants a slight contribution of meadow species of the *Molinietalia* order is marked.

The *Cicuto-Caricetum pseudocyperi* association occurs much less frequently and creates small patches within the area of mid-field water ponds. The *Cicuto-Caricetum pseudocyperi* phytocoenoses occur mainly in the water ponds adjacent to afforestation. In the patches of the association, *Carex pseudocyperus* is markedly dominant, both as regards the stability and the cover coefficient (S = V, D = 3500). The second species characteristic of the *Cicuta virosa* association reaches the IV degree of stability, but a small cover coefficient (D = 250). Of the species characteristic of the association, *Calla palustris* occurred least frequently. On average there were 11 taxons in the phytosociological

Table 2. Constancy (S) and cover coefficients (D) species rush communities of mid-field ponds in the western part of Drawskie Lakeland

Plant communities and their abbreviations	*Caricetum gracilis C.g.*		*Caricetum vesicariae C.v.*		*Caricetum acutiformis C.a.*		*Iridetum pseudacori I.p.*		*Cicuto-Caricetum* pseudocyperi *C.-C.*		*Typhetum latifoliae T.l.*		*Phragmitetum australis Phr.a.*		*Acoretum calami A.c.*		*Oenantho-Rorippetum O.-R.*		*Sparganietum erecti S.e.*		*Eleocharitetum palustris E.p.*		*Sparganio-Glycerietum fluitantis S.-G.*	
Number of relevés	14		15		10		13		11		18		16		12		10		10		10		14	
Number of species in communities	75		71		43		50		41		63		56		48		55		38		49		57	
Medium number species in relevé	19		16		12		12		11		15		13		12		15		12		14		14	
Constancy (S), cover coefficients (D)	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D
1	2		3		4		5		6		7		8		9		10		11		12		13	
ChAss. *Caricetum gracilis*																								
Carex gracilis	V	5000	II	80					II	91	II	67	II	131	II	58			II	150			II	107
ChAss. *Caricetum vesicariae*																								
Carex vesicaria	II	357	V	6250	III	375	IV	635	II	182	III	111	I	6	III	92	II	150	II	160	II	235	II	107
ChAss. *Caricetum acutiformis*																								
Carex acutiformis	I	36	II	200	V	7000	I	77	II	100	I	33	I	31	I	146	III	250	I	50				
ChAss. *Iridetum pseudacori*																								
Iris pseudacorus	II	321	II	107	I	50	V	5673			I	56	II	100	I	42	I	50	I	50			II	268
ChAss. *Cicuto-Caricetum pseudocyperi*																								
Carex pseudocyperus	I	36	I	100	II	70			V	3500	III	156	I	19			I	50	II	160	II	160		
Cicuta virosa									IV	250														
Calla palustris									II	500	I	11												

1	2		3		4		5		6		7		8		9		10		11		12		13	
I ChAll. *Magnocaricion*																								
Galium palustre	III	304	IV	340	III	250	IV	500	III	236	IV	267	III	144	III	217	III	220	III	170	III	500	IV	454
Phalaris arundinacea	IV	750	III	187	I	100	III	462	I	*55*	II	144	IV	263	III	458	II	160	II	160	II	450	II	114
Scutellaria galericulata	III	275	II	133	II	110	III	200	I	45	II	150	I	63	III	321	II	170	I	60	I	60	III	407
Carex rostrata	I	36	I	67	I	50			I	45	I	28	II	106	III	313	I	50	I	60	II	275		
Poa palustris			I	117			I	77			II	117	II	100										
ChAss. *Typhetum latifoliae*																								
Typha latifolia	III	643	II	107	III	210	I	38	IV	464	V	6667	II	138	I	83	I	60	II	120	I	50	II	196
ChAss. *Phragmitetum australis*																								
Phragmites australis	III	596	I	40	II	160	I	8	I	91	II	139	V	7344			I	175	III	130	III	460	I	71
ChAss. *Acoretum calami*																								
Acorus calamus													I	31	V	7083	II	110						
ChAss. *Oenantho-Rorippetum*																								
Oenanthe aquatica	II	150	I	67	I	10	I	8	I	18	I	28	I	19	III	125	V	4750	I	10	I	50	II	21
Rorripa amphibia	II	21					II	85	I	9	I	17	I	6			IV	875	II	70	I	10	II	57
ChAss. *Sparganietum erecti*																								
Sparganium erectum	I	71	I	67							II	50	II	81	I	83	II	150	V	6500	II	325		
ChAss. *Eleocharitetum palustris*																								
Eleocharis palustris	I	36	I	7					I	45	II	139					I	50	I	50	V	6250		
ChAss. *Sparganio-Glycerietum fluitantis*																								
Glyceria fluitans	II	107	II	133			II	258	II	100	I	11			II	92	II	200	II	160	III	220	V	6607

1	2		3		4		5		6		7		8		9		10		11		12		13	
ChAll. *Sparganio-Glycerion fluitantis*																								
Veronica beccabunga			I	7			I	8															II	268
II ChCl., O. *Phragmitetea, Phragmitetalia*																								
Alisma plantago-aquatica	III	339	III	127	II	70	II	62	II	73	III	156	III	131	III	117	III	250	III	180	III	635	III	171
Equisetum fluviatile	I	36	I	47	II	80	II	100			I	72	I	63	III	225	II	120	IV	150	II	245		
III ChCl. *Molinio-Arrhenatheretea*																								
Lysimachia vulgaris	III	968	IV	253	III	260	II	227	III	500	IV	358	III	119	II	133	III	260	II	195	I	100	III	221
Lythrum salicaria	II	29	III	73	II	30	II	154	III	36	II	100	III	50	I	17	II	40	III	90	II	30	II	129
Myosotis palustris	I	43	II	113			II	131	II	64	II	50	I	6	III	75	I	10	I	20	II	120	II	64
Lotus uliginosus	II	86	I	13	II	110	I	15	I	45	II	122	I	13	I	42	II	70			I	60	I	7
Juncus effusus	II	79	III	153			II	92	II	100	I	56	I	19			II	110					II	121
Epilobium palustre	II	86	III	100	III	130	I	38	I	18	II	61	II	50	I	8	I	20			I	20	I	14
Scirpus sylvaticus	II	168	I	47	I	20	II	212	I	*55*	II	122	I	13									II	79
Ranunculus repens	II	139	II	170	I	50	I	38			II	44					I	10					I	161
Potentilla anserina	I	43	I	73			I	8			II	139			I	42	I	10			II	150	I	36
Agrostis stolonifera			I	33							I	24	I	31			II	150			I	50		
Cirsium palustre	II	14	II	27			I	15	I	9													I	7

1	2		3		4		5		6		7		8		9		10		11		12		13	
Galium uliginosum	II	107	I	33	I	50	II	54					I	13										
Deschampsia caespitosa	II	179	II	283			I	15															II	79
Rumex crispus	II	29	I	40													I	10			I	10	I	7
Alopecurus geniculatus															I	42	I	50			II	400	I	7
Equisetum palustre	II	168	II	27																				
Filipendula ulmaria	II	50	I	7																				
Elymus repens	II	143			I	175																		
IV ChCl. *Lemnetea minoris*																								
Lemna minor	V	2679	III	513	III	470	III	585	III	418	V	381	IV	638	IV	821	IV	400	V	330	IV	525	IV	296
Spirodela polyrrhiza	I	71			I	100	I	38	I	91	I	6	I	63	II	167			II	275	I	50	II	143
Lemna trisulca	I	71			I	100			I	159	I	11	I	94					II	245	II	200	I	36
V ChCl.,O. *Potametea, Potametalia*																								
Potamogeton natans	I	14	I	67			I	8	I	45	II	117	I	63	I	83	I	10	I	10	II	325		
Hydrocharis morsus-ranae	I	36							II	136	II	111	I	94	I	42	I	50	I	10	I	50	I	36
Polygonum amphibium fo. *natans*	II	114							I	91	I	11	II	100	III	279	II	150	III	140	I	10		
VI ChCl. *Scheuchzerio-Caricetea nigrae*																								
Comarum palustre	III	625	II	167	II	150	II	115	I	91	II	139	I	31	I	8	I	10	I	10			II	321
Stellaria palustris	II	264	II	120	I	100	II	123	I	18	I	28	I	13	I	42	I	10			I	10	I	71

1	2		3		4		5		6		7		8		9		10		11		12		13	
VII ChCl., O., All. *Alnetea glutinosae, Alnetalia glutinosae, Alnion glutinosae*																								
Lycopus europaeus	IV	364	III	240	IV	445	III	177	III	314	V	444	IV	294	III	288	II	200	IV	190	III	210	III	157
1	2		3		4		5		6		7		8		9		10		11		12		13	
Solanum dulcamara	III	157	II	33	III	130	II	92	III	82	II	94	II	13	I	50	I	20	I	20	I	60	III	200
Calamagrostis canescens	II	375	II	140	I	60	I	15			II	100					I	50					II	179
Salix cinerea c			I	7	II	120					I	11	I	19							I	10		
VIII ChCl., O. *Bidentetea tripartiti*, *Bidentetalia tripartiti*																								
Bidens tripartita							I	15			II	144	I	19	I	50	III	90			II	410	II	64
Polygonum hydropiper	I	36					I	77			II	117			I	42	I	50			I	10	III	157
IX ChCl. *Artemisietea vulgaris*																								
Urtica dioica	II	293	I	40	I	10					III	225	III	156	I	42	III	90			I	60	I	71
Epilobium hirsutum	II	175	I	40	I	10			I	9	II	33	I	13			II	110	I	20	II	30		
Cirsium arvense	II	161	I	73	I	10					II	106	IV	219	I	17	I	10					II	107
Galium aparine	II	143	I	73											I	17	I	50					II	107
X Accompanying species																								
Polygonum amphibium fo. *terrestre*	II	143	I	33			I	77	I	9			II	131	III	217	II	110	III	140	I	20	I	125
Mentha aquatica							II	219			I	28	I	31			I	20	II	200	II	150	II	107

Sporadic: I: *Carex vulpina* (*C.g.*; *C.v.*; *I.p.*; *S.-G.*; *O.-R.*; *S.e.*); *Peucedanum palustre* (*C.v.*; *T.l.*; *Phr.a.*); II: *Glyceria maxima* (*C.g.*; *O.-R.*); *Rumex hydrolapathum* (*C.g.*; *C.v.*; *T.l.*); *Schoenoplectus lacustris* (*C.g.*; *C.-C.*; *Phr.a.*; *E.p.*); *Sium latifolium* (*C.v.*; *I.p.*; *A.c.; O.-R.*; *E.p.*); *Sparganium emersum* (*T.l.*; *S.e.*; *E.p.*); *Typha angustifolia* (*C.a.*; *S.-G.*; *T.l.*); III: *Agrostis gigantea* (*S.-G.*); *Alopecurus pratensis* (*C.g.*; *C.v.*); *Angelica sylve-*

stris (*C.g.*); *Caltha palustris* (*T.l.*; *S.e.*); *Cardamine pratensis* (*C.v.*; *C.a.*); *Carex cuprina* (*C.-C.*); *C. hirta* (*C.g.*; *C.v.*; *I.p.*; *S.-G.*); *Cirsium oleraceum* (*C.g.*; *C.v.*; *C.a.*; *T.l.*); *Climacium dendroides* d (*C.a.*); *Geranium palustre* (*C.g.*; *C.a.*); *Geum rivale* (*C.g.*; *C.v.*); *Hypericum tetrapterum* (*E.p.*); *Lathyrus pratensis* (*C.g.*; *C.v.*);*Lychnis flos-cuculi* (*C.v.*); *Lysimachia nummularia* (*C.v.; I.p.; S.-G.*); *Poa trivialis* (*C.g.*; *C.v.*; *T.l.*); *Ranunculus acris* (*C.g.*; *I.p.*; *T.l.*); *Rumex acetosa* (*C.g.*); *Stachys palustris* (*C.g.*; *C.v.*; *C.a.*; *S.-G.*; *T.l.*; *Phr.a.*); *Symphytum officinale* (*C.v.*; *C.a.*); *Vicia cracca* (*C.g.*); V: *Ceratophyllum demersum* (*Phr.a.*); *Hottonia palustris* (*C.g.*; *I.p.*; *S.-G.*; *A.c.*; *O.-R.*; *E.p.*); *Nuphar lutea* (*C.-C.*); *Nymphaea alba* (*Phr.a.*); *Potamogeton crispus* (*Phr.a.*; *E.p.*); *Stratiotes aloides* (*C.v.*; *T.l.*); *Utricularia vulgaris* (*S.e.*); VI: *Carex echinata* (*C.-C.*); *C. nigra* (*S.-G.*); *Drepanocladus aduncus* d (*C.v.*; *O.-R.*); *Juncus articulatus* (*S.-G.*; *T.l.*; *E.p.*); *Polygonum lapathifolium* subsp. *lapathifolium* (*S.-G.*); *Ranunculus flammula* (*C.v.*; *I.p.*; *Phr.a.*; *E.p.*); *Veronica scutellata* (*C.g.*; *C.v.*; *C.a.*; *I.p.*; *S.-G.*; *T.l.*; *Phr.a.*; *S.e.*; *E.p.*); VIII: *Bidens cernua* (*S.-G.*; *Phr.a.*; *A.c.*; *E.p.*); *Ranunculus sceleratus* (*C.g.*; *I.p.*; *S.-G.*; *Phr.a.*; *A.c.*; *O.-R.*; *E.p.*); *Rumex maritimus* (*C.g.*; *O.-R.*); IX: *Epilobium parviflorum* (*Phr.a.*); *Glechoma hederacea* (*C.v.*; *A.c.*); *Myosoton aquaticum* (*Phr.a.*); *Veronica chamaedrys* (*A.c.*); X: *Brachythecium oedipodium* d (*C.g.*); *Calliergonella cupsidata* d (*C.g.*); *Dicranella heteromalla* d (*C.g.*); *Mentha arvensis* (*C.v.*; *T.l.*); *M. verticillata* (*I.p.*); *Plagiomnium undulatum* d (*C.v.*; *C.a.*); *Polygonum persicaria* (*C.v.*; *S.-G.*; *A.c.*; *O.-R.*); *Rumex conglomeratus* (*A.c.*); *Salix viminalis* c (*T.l.*); *Scrophularia nodosa* (*T.l.*); *Stellaria graminea* (*C.g.*; *T.l.*); *Isoëto-Nanojuncetea*: *Gnaphalium uliginosum* (*I.p.*; *A.c.*); *Juncus bufonius* (*A.c.*); *Stellarietea mediae*: *Fallopia convolvulus* (*S.-G.*; *A.c.*; *O.-R.*).

Table 3. The standard deviation with reference to the mean number of species in the relevés of rush communities

Associations	Number of relevés	Mean	Standard deviation
All. *Magnocaricion*			
Caricetum vesicariae	15	13.50	3.89
Caricetum gracilis	14	18.57	3.27
Iridetum pseudacori	13	11.77	3.11
Caricetum acutiformis	10	11.90	2.33
Cicuto-Caricetum pseudocyperi	11	11.09	2.30
All. *Phragmition*			
Typhetum latifoliae	18	15.33	3.79
Phragmitetum australis	16	11.81	3.25
Oenantho-Rorippetum	10	14.50	3.21
Acoretum calami	12	12.25	2.14
Eleocharitetum palustris	10	13.80	2.10
Sparganietum erecti	10	12.20	1.55
All. *Sparganio-Glycerion fluitantis*			
Sparganio-Glycerietum fluitantis	14	13.86	2.88

record and the total number of species in the phytocoenoses of *Cicuto-Caricetum pseudocyperi* amounted to 41.

The *Typhetum latifoliae* association was often observed within the area of mid-field ponds of the studied terrain. The mean number of the plant species in the relevé amounted to 15 (minimum 8, maximum 20). In the described phytocoenoses the presence of 63 plant species was observed. Taxons building broadleaf rushes (*Typhetum latifoliae*) represent, first of all, the *Phragmitetea* class and its lower syntaxons (24 species). Due to the aggregate character of the described association, the phytocoenoses representing it, were often dominant in the littoral zone of the studied bodies of water.

The *Phragmitetum australis* association is often found around mid-field ponds. Phytocoenoses of the association are floristically poor. The mean number of species in the relevé amounted to13 taxons (minimum 9 taxons, maximum 18). Altogether, in 16 patches of vegetation 56 species of vascular plants were registered. The dominating taxon in the association is *Phragmites australis* (S = V, D = 7344), showing significant expansiveness and creating the largest amount of biomas in the community. For this reason it plays a considerable role in successive processes of terrestrialisation of bodies of water (Matuszkiewicz, 2007). *Phragmites australis* participates in all the stages of the overgrowing of bodies of water. Whereas *Typha latifolia*, disappearing in the case of the lack of constant flooding, participates only in the final stages of terrestrialisation (Dąbkowski and Pachuta, 1996). Within patches of the discussed association, the variant with *Lemna minor* was distinguished. Also the species of the *Magnocaricion* alliance are often and in numerous numbers observed. The second variant is marked by the presence of *Urtica dioica* and a more numerous contribution of characteristic species of the

Molinio-Arrhenetheretea class. These phytocoenoses settle in fertile, periodically drying habitats.

Individual patches of phytocoenoses *Acoretum calami* are mainly built by the characteristic species of the association *Acorus calamus* (S = V, D = 7083). Florisically it is a poor community. The mean number of the plant species in the relevé amounted to 12 taxons. Altogether, 48 species were found in the patches of the association, including 16 of the *Phragmitetea* class. The characteristic species creates dense stands in the littoral zone, where permanent anthropopression is clearly marked. *Acoretum calami* is a markedly nitrophilous community, lushly growing in the bodies of water, where there is a constant inflow of a larger amount of nitrogen and phosphorous compounds.

The *Oenantho-Rorippetum* association is characteristic of small astatic bodies of water. It creates small surface patches in the studied area. Phytocoenoses, which form it, are not very rich floristically. On average 15 plant species were recorded in the relevé. Altogether, 55 species were found to be present in the association. In a part of patches, of the species characteristic of the association, *Oenanthe aquatica* occurred exclusively. In the remaining patches, *Rorippa amphibia* was also recorded, although in lower degrees of quantity.

Sparganietum erecti association is formed fragmentarily in the littoral zone of mid-field water ponds. The characteristic *Sparganium erectum* species of the association, despite the fact that it was often found in the studied area, very rarely forms dense phytocoenosis and only in small areas. The association is floristically poor. Totally, the presence of 38 plant species were stated within its range. Individual patches are characterised by a similar number of species (maximum 14, minimum 10), on average 12 taxons in a relevé. The dominating share in the *Sparganietum erecti* phytocoenoses have the species of the *Phragmitetea* class. There are 20 of them along with the characteristic species of the association. Phytocoenoses of the association settle generally in quiet places where they are not threatened by large water waving. For this reason, within their range, a larger number of pleuston species are found, among others, *Lemna minor* (S = V) and *Polygonum amphibium* f. *natans* (S = III) – Table 2.

The *Eleocharitetum palustris* association creates small patches in the littoral zone of the ponds. The characteristic species occurs in loose concentrations and in two records it reached the 5th degree of quantity. A mean number of the species in the relevé amounted to 14. Totally, 15 plant taxons were observed in the phytocoenoses of the association. 18 plant species of the *Phragmitetea* class and and its lower syntaxons occurred. The presence of the species of the *Molinio-Arhhenatheretea* class proves the invasion of the taxons from the adjacent meadow phytocoenoses into the patches of this association.

The *Sparganio-Glycerietum fluitantis* association is marked by the domination of *Glyceria fluitans* (S = V, D = 6607). In the patches of the association, due to a different type of habitats, the other characteristic species *Mimulus guttatus*, occurring at the banks of rivers, was not found to be present. For this reason, the association recorded around the mid-field ponds should be classified according to MATUSZKIEWICZ (2007) as less typical forms. Of the species characteristic of the *Sparganio-Glycerion fluitantis* alliance, only *Veronica beccabunga* occurred in the discussed community, whereas the *Magnocaricion* alliance of the *Phragmitetea* class was represented quite numerously

(7 species) and so were the *Molinio-Arrhenatheretea* class and its lower syntaxons (17 species). The association creates not quite dense communities of *Phalaridetum arundinaceae* w in the littoral zone of mid-field ponds. The mean number of species in the patches of the association equalled 14. Altogether, 57 taxons occurred in the association.

4. Discussion

Most of the studied ponds in the western part of Drawskie Lakeland has a well developed belt of rushes. It is important for the preservation of these objects as, to a large extent they uptake biogenes, mainly potassium and nitrogen and then calcium and phosphorus. (ARCZYŃSKA-CHUDY *et al*., 1996; SZYPEREK, 2005) and in this way they inhibit the process of eutrophication of the these bodies of water. Studies by KOC and SZYPEREK (2001) proved that the belt of rushes surrounding a pond accumulates more biogenes than the belt of meadow vegetation or the belt of afforestation. BOSIACKA and PIEŃKOWSKI (2003) remark that there is a positive relationship between the size of a pond and the number of the species found within its area and the floristic value of individual objects. The disappearance of water table decides about the reduction in aquatic and rush vegetation and about the process of succession heading towards meadow or ruderal communities (PIEŃKOWSKI *et al*., 2004; TOMASZEWSKA and SŁAPEK, 2004; GAMRAT and GAŁCZYŃSKA, 2006; GAMRAT *et al*., 2006; 2007; GAMRAT, 2009). KRASKA *et al*. (2002) observed that even multiannual disappearance of the water table leads to irreversible impoverishment or destruction of vegetation. Whereas such an effect can be caused by anthropogenic factors (BOSIACKA and PIEŃKOWSKI, 2003). GAMRAT and GAŁCZYŃSKA (2008) remark upon larger anthropophytization of the flora of the ponds situated in the vicinity of villages as compared to the mid-field ponds. HELFRICH *et al*. (2000) recommend controlling water ponds to see the degree to which the water table is covered by plants and in case the cover is large they suggest endeavours leading to its ruderal reduction. The disappearance of the water ponds occurs less frequently than their appearance (PIEŃKOWSKI *et al*., 2004). The newly formed ponds in the process of ecological succession are in a very short time settled by water and swamp vegetation (PAYDER, 1994).

Due to the differentiation of ecological conditions, water ponds are a habitat, first of all, of many water and swamp communities, but also meadow, ruderal and shrub communities, which results in, among other things, large biodiversity of these biotopes (HILLBBRICHT-ILKOWSKA, 1998). Among them, there are rare or endangered communities. Of the distinguished associations in the area of research, one – *Sparganio--Glycerietum fluitantis* is recognized as locally endangered (RATYŃSKA, 1997). Of the communities which are in danger of extinction, distinguished for Wielkopolska (Greater Poland) by BRZEG and WOJTERSKA (1996), two communities from the investigated area – *Cicuto-Caricetum pseudocyperi* and *Caricetum vesicariae* were described. Of the communities of indefinite danger, also two associations were characterised: *Iridetum pseudacori* and *Sparganio-Glycerietum fluitantis*. All these associations, apart from *Cicuto-Caricetum pseudocyperi* were also observed around the ponds in communes of

Karlino and Kołobrzeg by BOSIACKA and RADZISZEWICZ (2002; 2003). BOSIACKA and PIEŃKOWSKI (2004) identified 35 plant communities, including 12 locally rare and endangered communities within the area of 53 ponds in Nowogard Plain. The studies of the same authors (BOSIACKA and PIEŃKOWSKI, 2003) in Myślibórz Lakeland showed the presence of 31 communities, including 8 rare and endangered communities within the area of 51 ponds. WALDON (2002) studied plant cover of 50 water ponds and areas adjacent to them in Pojezierze Krajeńskie (Krajeńskie Lakeland), including mid-field, mid-forest and mid-meadow water ponds and the ones situated near buildings. She distinguished 124 plant communities, in which she recorded 380 species. The studies showed that mid-forest water bodies are the objects of the most natural character.

The most frequently observed rush communities in the area of the studies are: *Typhetum latifoliae*, *Phragmitetum australis* and *Caricetum vesicariae*. GAMRAT (2009) clasified *Oenatho-Rorippetum, Phalaridetum arundinacae*, *Typhetum latifoliae* and *Phragmitetum australis* as the associations most often formed round the ponds in Wełtyn Plain. BOSIACKA and PIEŃKOWSKI (2004) found *Phalaridetum arundinacae*, *Typhetum latifoliae* and *Sparganietum erecti* to be most frequent in Nowogard Plain, whereas in Myślibórz Lakeland – *Phragmitetum australis*, *Sparganietum erecti*, *Phalaridetum arundinacae* and *Sparganio-Glycerietum fluitantis* (BOSIACKA and PIEŃKOWSKI, 2003).

SZOSZKIEWICZ and ŁAWNICZAK (2002) analysed species diversity of 10 most common associations of selected lakes in Pojezierze Brodnickie (Brodnickie Lakeland), including six rush associations, using Renyi's method of diversity indices. Among them the highest diversity was characteristic of the *Sparganietum erecti* association. Also, for this association the authors obtained the largest standard deviation of the species number in the relevés, whereas the smallest for *Caricetum acutiformis*.

5. Conclusions

- Around mid-field ponds in the western part of Drawskie Lakeland differentiation of rush vegetation develops.
- The rushes of the *Phragmition* alliance are most often represented by the *Typhetum latifoliae* and *Phragmitetum australis* associations and the *Magnocaricion* rushes (the *Magnocarion* alliance) by *Caricetum acutiformis* and *Caricetum gracilis*.
- The least frequantly observed association was *Cicuto-Caricetum pseudocyperi*, which occurs exclusively in the ponds situated in the afforested complexes.
- The richest floristically are the associations *Caricetum gracilis* (75 taxa) and *Caricetum vesicariae* (71 species), and the poorest – *Sparganietum erecti* (38 taxa).
- The rush communities show a larger mutual floristic similarity within the alliances *Magnocaricion* and *Phragmition*, than between themselves.

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Zróżnicowanie zbiorowisk szuwarowych śródpolnych oczek wodnych w zachodniej części Pojezierza Drawskiego

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Streszczenie

W zachodniej części Pojezierza Drawskiego wykonano 153 zdjęcia fitosocjologiczne w obrębie zbiorowisk szuwarowych 30 oczek śródpolnych. Wyróżniono 12 zbiorowisk roślinnych w randze zespołu: *Sparganietum erecti*, *Eleocharitetum palustris*, *Phragmitetum australis*, *Typhetum latifoliae*, *Acoretum calami*, *Oenantho-Rorippetum*, *Cicuto-Caricetum pseudocyperi*, *Iride-*

tum pseudacori, *Caricetum acutiformis*, *Caricetum gracilis*, *Caricetum vesicariae* and *Sparganio-Glycerietum fluitansis*. Fitocenozy: *Caricetum gracilis* (75), *Caricetum vesicariae* (71) i *Typhetum latifoliae* (63 taksony) są najbogatsze florystycznie, natomiast najuboższe *Sparganietum erecti* (38) i *Cicuto-Caricetum pseudocyperi* (41 gatunków). Dominują w nich gatunki charakterystyczne klasy *Phragmitetea* i *Molinio-Arrhenatheretea*. W zespołach szuwarowych związku *Magnocaricion* udział gatunków z obu klas jest mniej więcej zbliżony. Szuwary wielkoturzycowe kontaktują się ze zbiorowiskami związku *Phragmition* oraz ze zbiorowiskami wilgotnych łąk rzędu *Molinietalia*, stąd udział w nich gatunków z obu klas. W fitocenozach związku *Phragmition* (szuwary właściwe) mniej jest gatunków z klasy *Molinio-Arrhenatheretea* a nieco więcej gatunków z klasy *Potametea* niż w zbiorowiskach związku *Magnocaricion*. Szuwary właściwe ze związku *Phragmition* są najczęściej reprezentowane przez *Typhetum latifoliae* (dominacja *Typha latifolia* – S = V, D = 6667) i *Phragmitetum australis* (dominacja *Phragmites australis* – S = V, D = 7344). Ze związku *Magnocaricion* najczęściej występowało zbiorowisko *Caricetum vesicariae* (dominuje *Carex vesicaria* – S = V, D = 6250). Najrzadziej spotykano zespół *Cicuto-Caricetum pseudocyperi* – występował on wyłącznie wokół oczek otoczonych zwartymi zadrzewieniami. Przeprowadzono analizę podobieństwa zbiorowisk metodą UPGMA z wykorzystaniem odległości euklidesowych na podstawie stałości fitosocjologicznej gatunków przy użyciu pakietu STATISTICA PL (1984–1985). Wyliczono współczynniki podobieństwa zespołów metodą Sörensena, a uzyskane wyniki przedstawiono w diagramie Czekanowskiego.

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