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WATER PLANT ASSOCIATIONS IN THE VALLEY OF THE CYBINA RIVER*

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ABSTRACT. The paper contains description of 18 associations of water vegetation, belonging to three classes: *Lemnetea*, *Charetea* and *Potametea*. They were found in rivers, lakes and other water bodies, situated in the Cybina Valley. 10 of them are threatened in the Wielkopolska Region. The lakes in a flux of the Cybina River were devoid of submerged vegetation, due to low water transparency.

Key words: plant associations, duckweed, stoneworts, submerged vegetation, nymphaeids

Introduction

Cybina is a 41-km long river, the right tributary of the Warta River, which is the main river in the region. Cybina and its tributaries are typical lowland rivers with low decline of their riverbeds and many natural lakes and artificial reservoirs in their water-courses. According to geomorphological division of **Kondracki** (1994), the Cybina catchment area is situated on the Wrzesińska Plain. The river flows in a deep (up to 30 m) and narrow valley through the Plain. Within this valley there are four lakes situated on the Cybina River course (Swarzędzkie, Uzarzewskie, Góra and Iwno) and two nameless without any flow, placed below the northern slope of the valley, between villages Uzarzewo-Huby and Biskupice. The artificial water bodies include five man-made reservoirs, created on the Cybina River within the administration of the Poznań city (Maltański, Olszak, Browarny, Młyński and Antoninek) as well as many peat bogs spread along the valley, fish ponds and sand or gravel mining lakes. Riverbeds within the valley, both

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belonging to the Cybina and lower courses of its tributaries, which cut the slopes of valley with deep canyons, are seminatural. In the past they were periodically regulated by the melioration measures. Such an activity during the last 20 years was almost completely abandoned, what enabled the secondary succession of plants. Most of the waters should be noted as eutrophic or even hypertrophic, as they are intensely loaded with nutrients flowing from the areas of agricultural drainage area and ponds with intensive fish farming. In the past they were also polluted by municipal wastewater. Building of some modern sewage treatment plants in the catchment area of the Cybina River and sewage diversion from some localities in the area, causes gradual improvement of quality of the surface waters (Goldyn and Grabia 1998, Goldyn 2000, Goldyn and Kowalczywska-Madura 2005, Kowalczywska-Madura 2005).

This study was a part of interdisciplinary studies, which aim was nature valorisation in the valley of the Cybina River. During these surveys a large variety of species, phytocoenoses, zoocoenoses and habitats within the valley was proved. Many of these elements belong to protected, rare or threatened in Poland and/or in the Wielkopolska Region. It was proposed to take under protection the entire Valley in a form of an area of protected landscape (Walory przyrodnicze... 2005). The surveys were made thanks to financial support obtained from the company Zeelandia in Tarnowo Podgórne. Detailed documentation of water plant communities detected herein should help in the future comparative studies, documenting the expected recovery of submerged plant associations to the lakes and other water bodies.

Methods of the studies

Field survey of communities belonging to the classes: *Lemnetea*, *Charetea* and *Potamogetea* were made in vegetation season 2004. 50 phytosociological records were made using Braun-Blanquet method (Fukarek 1967, Matuszkiewicz 2001). Classification of water plant associations, data regarding to the frequency of their occurrence in the Wielkopolska Region and their threat were accepted according to Brzeg and Wojterska (2001). Names of plant species were accepted according to the checklist of Mirek et al. (2002).

Division of a course of the Cybina River into 1-kilometre sections, started from its mouth near the side channel of the Warta River in Poznań and finished at the river source near Nekielka, was accepted according to Goldyn and Grabia (1998). It was used in tables and in the text for the description of communities, namely the places of their occurrence in the Cybina River as well as in its tributaries and other water bodies, situated inside the valley.

Distinguished plant communities

- Class *Lemnetea minoris* (R. Tx. 1955) de Bolós et Masclans 1955
- Order *Lemnetalia minoris* (R. Tx. 1955) de Bolós et Masclans 1955
- Alliance *Lemnion minoris* (R. Tx. 1955) de Bolós et Masclans 1955

1. *Lemnetum minoris* Soó 1927
2. *Lemnetum trisulcae* (Kelhofer 1915) R. Knapp et Stoffers 1962
3. *Lemno-Spirodeletum polyrhizae* W. Koch 1954 ex Th. Müller et Görs 1960
Alliance *Hydrocharition morsus-ranae* Rübel 1933
4. *Lemno-Hydrocharitetum morsus-ranae* (Oberd. 1957) Pass. 1978
5. *Lemnetum gibbae* (Bennema et al. 1943) Miyawaki et J. Tx. 1960
- Class *Charetea fragilis* Fukarek 1961 ex Krausch 1964
Order *Charetalia hispidae* Sauer 1937 ex Krausch 1964
Alliance *Charion vulgaris* Dąmbska 1966 ex W. Krause 1981
6. *Charetum vulgaris* Corillion 1957
- Class *Potametea* R. Tx. et Prsg. 1942 ex Oberd. 1957
Order *Potametalia* W. Koch 1926
Alliance *Potamion pectinati* (W. Koch 1926) Görs 1977
7. *Potametum lucentis* Hueck 1931
8. *Potametum pectinati* (Hueck 1931) Carstensen 1955
9. *Elodeetum canadensis* Eggler 1933
10. *Ceratophylletum demersi* Hild 1956
11. *Ceratophylletum submersi* Soó 1928
12. *Myriophylletum verticillati* Gaudet 1924
13. *Myriophylletum spicati* Soó 1927 ex Podbielkowski et Tomaszewicz 1978
Alliance *Nymphaeion* Oberd. 1957
14. *Nymphaeo albae-Nupharetum luteae* Nowiński 1928 nom. mut.
15. *Potametum natantis* Soó 1927 ex Podbielkowski et Tomaszewicz 1978
Alliance *Ranunculion fluitantis* Neuhäusl 1959
16. *Hottonietum palustris* R. Tx 1937 ex Pfeiffer 1941
17. *Ranunculo-Callitrichetum polymorphae* Soó 1927
18. *Beruletum submersae* Roll 1938

1. *Lemnetum minoris* (Table 1, record 1)

As a rule it is one-layer association, made by pleustonic species with domination of *Lemna minor* and partial occurrence of *Lemna trisulca* and *Spirodela polyrhiza*. Very dense cover of plants caused, that entire water column was devoid of the access of light, which prevented the development of submerged macrophytes. Because of easy mobility of lemnid species under the wind influence (especially in bigger water bodies), they reach a big density nearby the windward bank, while in the same time near the opposite bank there is loose density. Submerged vegetation may appear then, especially *Ceratophyllum demersum* and *C. submersum* as well as plants with floating leaves, like *Polygonum amphibium* f. *natans*. Lemnids pushing by the wind often cause complex communities, together with helophytes from the class *Phragmitetea*, especially with *Phragmites australis*, *Typha angustifolia* and *T. latifolia*. Density of pleustonic plants increases usually during the summer, reaching its maximum in August.

Lemnetum minoris is a common association in almost all water bodies along the Cybina Valley, especially in peat bogs and ponds. Its patches are very popular also in preliminary man-made reservoirs in Poznań (Olszak, Browarny, Młyński and Antoninek) as well as in wind-sheltered bays of the lakes. It occurs also in the Cybina River, especially during the late summer, when water in its bed flows very slowly and on the sections with small decline practically stagnates.

Table 1

Associations from the class *Lemnetea*
Zespoły z klasy *Lemnetea*

Zespół – Association	<i>Lemnetum minoris</i>	<i>Lemnetum trisulcae</i>			<i>Lemno-Spirodelleum</i>		<i>Lemno-Hydrocharitetum morsus-ranae</i>
		2	3	4	5	6	
Succeeding no of record in the table Kolejny numer zdjęcia w tabeli	1	2	3	4	5	6	7
Kilometre of the river course Kilometr biegu rzeki	31	35	22	27	22	22	10
Field no of the record Nr zdjęcia w terenie	96	54	51	12	173	174	130 a
Date – Data	22.07.04	22.06.04	17.06.04	3.06.04	25.08.04	25.08.04	19.08.04
Cover of herb layer – c (%) Pokrycie warstwy zielonej – c (%)	+	15	–	+	–	–	–
Cover of layer d (%) Pokrycie warstwy d (%)	100	100	80	100	100	90	100
Water depth (cm) Głębokość wody (cm)	0-40	30	70	100	30	50	50
Surface of the record (m ²) Powierzchnia zdjęcia (m ²)	10	5	20	20	6	16	8
No of taxa in the record Liczba taksonów w zdjęciu	6	9	4	5	3	5	4
I. Ch. *Ass. et <i>Lemnetea</i>							
* <i>Lemna minor</i>	5.5	3.3	1.1	1.1	3.3	3.3	2.2
* <i>Lemna trisulca</i>	·	5.5	5.5	5.5	4.4	1.1	·
* <i>Spirodela polyrhiza</i>	+	·	2.2	5.5	4.4	4.4	+
<i>Hydrocharis morsus-ranae</i>	·	+	·	·	·	·	5.5
II. Ch. <i>Potametea</i>							
<i>Ceratophyllum submersum</i>	3.3	·	+	·	·	·	2.2
<i>Polygonum amphibium</i> f. <i>natans</i>	3.3	·	·	·	·	·	·
<i>Berula erecta</i>	·	·	·	·	·	+2	·
<i>Nuphar lutea</i>	·	·	·	·	·	+	·

Sporadic species: – Gatunki sporadyczne:

Ch. *Phragmitetea*: *Carex acutiformis* 4, *C. riparia* 2 (+2), *Lycopus europaeus* 2, *Phalaris arundinacea* 1, *Phragmites australis* 2 (1.2), *Rorippa amphibia* 2, *Solanum dulcamara* 2, *Typha angustifolia* 2, *T. latifolia* 4.

Accompanying species: – Gatunki towarzyszące: *Urtica dioica* 1.

2. *Lemnetum trisulcae* (Table 1, records 2-4)

This association, similarly to *Lemnetum minoris*, develops in eutrophic, small water reservoirs or wind-sheltered bays of bigger water bodies. It often creates a community consisting of two layers, where on the surface occur *Lemna minor* and *Spirodela polyrhiza* and beneath, in the water column – *Lemna trisulca*. Such phytocoenoses refer to the older conception of the association *Lemno-Spirodeletum*, in which all species stated above were recognized as characteristic (Podbielkowski and Tomaszewicz 2001). Because of shading the bottom by duckweeds, species of submerged macrophytes from the *Potametea* class are rarely found in patches of this association. However, along the shorelines, in shallow water, species of rush- and sedge-vegetation from the class *Phragmitetea* can be often found.

Phytocoenoses of association dominated by *Lemna trisulca* occur in various water bodies along all the Cybina Valley, but mostly in peat bogs and ditches with stagnant water.

3. *Lemno-Spirodeletum polyrhizae* (Table 1, records 5-6)

Phytocoenoses of this association consist mostly of pleustonic plants, dominated by *Spirodela polyrhiza*. They usually occur on the surface of slow-moving waters, because the giant duckweed thanks to bigger thalli and clusters of roots hanging in the water can anchor more easily than other duckweed species. *Lemna minor* and *L. trisulca* often accompany the characteristic species. Along the shoreline of the reservoirs in such patches may occur species of rush- and sedge-vegetation. In deeper water plants with floating leaves replace them. Dense cover of duckweeds causes shading of water, which prevents development of submerged macrophytes.

Phytocoenoses of this association have been stated in the bed of the Cybina River as well as in a ditch that connected this river and a peat bog situated between Jankowo and Góra. They occur also in wind-sheltered bays of the Swarzędzkie Lake, especially in its southwestern, shallow part. Periodically they cover also water surface in the reservoirs in Poznań, especially the Browarny Reservoir.

4. *Lemno-Hydrocharitetum morsus-ranae* (Table 1, record 7)

Usually it is one-layer association of pleustonic plants, which covers water surface, in strongly eutrophic, small water bodies. It was found within the Cybina Valley in wind-sheltered bays of the Swarzędzkie and Iwno Lakes, often in the vicinity of thick mat of floating plants, built by phytocoenoses of *Cicuto-Caricetum pseudocyperii*.

5. *Lemnetum gibbae*

This duckweed association usually consists of one layer, with domination of characteristic species *Lemna gibba* accompanied by *L. minor*, which often has a big share. *L. gibba* is a stenothermic species (Casper and Krausch 1981), which occurs in warm water of shallow, sheltered reservoirs. Because summer 2004 was not very hot, this association was not noticed and phytosociological records were not done.

Well-developed patches of this association were noticed in preliminary reservoirs situated in Poznań (Olszak, Browarny, Młyński and Antoninek) in 1995 (Goldyn 2000) – km 5, 6, 7 and 8. Its occurrence during hot summers should be expected also in the

Swarzędzkie Lake, situated upstream. This association occurs on dispersed places in the Wielkopolska Region (**Brzeg and Wojterska 2001**) and has been recognized as endangered in V category, mainly because of the rarity of characteristic species – *Lemna gibba*.

6. *Charetum vulgaris* (Table 2)

Table 2

Association *Charetum vulgaris*
Zespół *Charetum vulgaris*

Succeeding no of record in the table Kolejny numer zdjęcia w tabeli	1	2
Kilometre of the river course Kilometr biegu rzeki	14	14
Field no of the record Nr zdjęcia w terenie	188	187
Date – Data	26.08.04	26.08.04
Cover of herb layer – c Pokrycie warstwy zielnej – c	+	+
Cover of layer d (%) Pokrycie warstwy d (%)	100	100
Water depth (cm) Głębokość wody (cm)	50	25
Surface of the record (m ²) Powierzchnia zdjęcia (m ²)	48	12
No of taxa in the record Liczba taksonów w zdjęciu	5	5
I. Ch. Ass. <i>Chara vulgaris</i>	5.5	5.5
II. Ch. Potametea <i>Potamogeton natans</i>	+	1.1
<i>Ceratophyllum demersum</i>	3.3	+
<i>Myriophyllum spicatum</i>	2.2	·
III. Ch. Phragmitetea <i>Phragmites australis</i>	+	1.1
<i>Typha latifolia</i>		+

Association of the stoneworth *Chara vulgaris* is considered as a pioneer in plant succession in recently constructed water reservoirs. It was found in small and shallow (periodically even drying up) water bodies in the Cybina Valley formed as a result of

sand or gravel mining on hillocks situated on the bottom of the valley, East from Gruszczyn (km 14 and 15). *Chara vulgaris* creates dense submerged meadows there, up to 1 m of water depth. Because of a good water transparency, it is accompanied by many elodeids like *Ceratophyllum demersum*, *Myriophyllum spicatum* and *Elodea canadensis*. Plants with floating leaves like *Potamogeton natans* develop as well. This association occurs mostly in southeastern and middle part of Poland (Dąbbska 1966).

In the Wielkopolska Region the association has been noticed as endangered in V category. It is vulnerable because of short-living and ephemeral character of its living places.

7. *Potametum lucentis* (Table 3, records 1-2)

Species creating phytocoenoses of this association are *Potamogeton lucens* and *P. crispus*. They may occur together; however, in the Cybina Valley they made independent patches. Except of the characteristic species only sparse representatives of the alliance *Potamion pectinati* and the class *Lemnetea* have been found. From the shore side these patches were entered by only single specimens of helophytes – reed and cat-tail.

Occurrence of *Potametum lucentis* in the Cybina Valley has been noticed at scarce localities: in ponds near Wiktorowo, in a bed of the Cybina River upstream from the Iwno Lake and in lower course of its right tributary – Szkutelnik.

The association is widespread all over the country. It occurs mainly in eutrophic lakes, but with not very advanced trophy (Tomaszewicz 1978, Podbielkowski and Tomaszewicz 2001). In the Wielkopolska Region this association has been recognized as endangered in I category. The observed disappearing of its phytocoenoses is connected with intensive deterioration of water quality in many lakes, especially with decreasing of their transparency. Eutrophication process induces water blooms and cause disappearing of communities of submerged vegetation. The association *Potametum lucentis* disappears as the first one, because of its occurrence in the deepest littoral of lakes, where the light stops to reach the bottom earliest.

Because of advance trophy of lakes situated on the course of the Cybina River (hypertrophy) and small water transparency (less than 1 m), this association was not met in those lakes. Its occurrence in shallow ponds and rivers within the Valley allows to believe that increase of water quality in lakes after their protection and/or restoration make possible their recolonisation by phytocoenoses of *Potametum lucentis* and other associations.

8. *Potametum pectinati* (Table 3, record 3)

It is the association of submerged plants, which occurs in strongly eutrophic waters. Structure of its patches consists mostly of the characteristic species, with smaller share of other plants from *Potametea* class. Depth of their occurrence depends on water transparency. They develop in the Maltański Reservoir, at the boatyard in the Swarzędzkie Lake and in fishpond in Promno, always only in shallow littoral, where water depth does not exceed one meter.

This association is often noticed in eutrophic waters both in Poland and in the Wielkopolska Region. Their phytocoenoses retreat as the last from hypertrophic lakes, so it should be expected that they would return as the first ones after improvement of water quality.

Table 3

Associations from the alliance *Potamion pectinati*
Zespoły roślinne ze związku *Potamion pectinati*

Association – Zespół	<i>Potametum lucentis</i>		<i>Potametum pectinati</i>	<i>Elodeetum canadensis</i>	<i>Ceratophylletum demersi</i>						<i>Ceratophylletum submersi</i>				<i>Myriophylletum verticillati</i>		
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Succeeding no of record in the table Kolejny numer zdjęcia w tabeli	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Kilometre of the river course Kilometr biegu rzeki	34	36	3	29	32	11	35	33	12	10	10	10	14	31	22	20	20
Field no of the record Nr zdjęcia w terenie	73	59	42b	38	97	129	53	77	118	133	130	135	191	201	42a	197	198
Date – Data	14.07.2004	22.06.2004	15.07.2004	11.04.2004	22.07.2004	19.08.2004	22.06.2004	14.07.2004	19.08.2004	19.08.2004	19.08.2004	19.08.2004	26.08.2004	24.09.2004	17.06.2004	21.09.2004	21.09.2004
Cover of herb layer – c (%) Pokrycie warstwy zielnej – c (%)	+	+	-	-	+	-	30	+	+	+	-	-	+	100	+	+	+
Cover of layer d (%) Pokrycie warstwy d (%)	75	100	90	100	100	35	100	80	100	100	100	100	80	+	100	100	100
Water depth (cm) Głębokość wody (cm)	20-35	20-50	60	5-30	5-50	50	70	30	50-100	50	120	140	20	50	60	0-30	30-100
Surface of the record (m ²) Powierzchnia zdjęcia (m ²)	5	18	10	6	20	30	10	6	40	100	60	100	20	15	100	15	15
No of taxa in the record Liczba taksonów w zdjęciu	4	7	3	7	4	1	8	4	5	5	2	4	6	3	4	7	4
I. Ch. Ass.																	
<i>Potamogeton lucens</i>	4.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 3 – cont.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
<i>Potamogeton crispus</i>	.	5.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Potamogeton pectinatus</i>	.	.	5.5	+	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Elodea canadensis</i>	.	.	.	5.5	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Ceratophyllum demersum</i>	.	+	+	.	5.5	3.3	5.5	4.4	5.5	5.5	5.5	2.2	.	.	.	.	.
<i>Ceratophyllum submersum</i>	.	+	1.1	+	4.4	4.4	5.5	5.5	.	.
<i>Myriophyllum verticillatum</i>	5.5	5.5
<i>Potamogeton perfoliatus</i>	.	.	+
II. Ch. Lemnetea																	
<i>Lemna minor</i>	.	+	.	+	.	.	2.2	1.1	1.2	2.3	1.1	1.1	2.2	1.2	.	.	.
<i>Spirodela polyrhiza</i>	.	1.1	.	.	.	.	+	2.3	+	+	+	+	1.1	.	.	.	.
<i>Lemna trisulca</i>	3.3	.	.	.	.	.	2.2	.	.	.	.
<i>Hydrocharis morsus-ranae</i>	1.2	1.2	.	.	.	.	.	.	.
<i>Utricularia vulgaris</i>	+	.
III. Ch. Phragmitetea																	
<i>Typha angustifolia</i>	+	.	+	+	+	1.2
<i>Phragmites australis</i>	+2	.	.	.	.	.	3.3	.	.	.	.	.	+	.	.	.	+
<i>Typha latifolia</i>	+2	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.

Sporadic species: – Gatunki sporadyczne:

Ch. *Potametea*: *Fontinalis antipyretica* 17, *Nymphaea alba* 16 (1.2), *Polygonum amphibium* f. *natans* 15, *Potamogeton natans* 5.

Ch. *Phragmitetea*: *Acorus calamus* 5, *Alisma plantago-aquatica* 8, *Berula erecta* 4, *Carex acutiformis* 15, *Glyceria maxima* 2, *Mentha aquatica* 7, *Rorippa amphibia* 2, *Sparganium erectum* 14, *Veronica beccabunga* 4.

Accompanying species: – Gatunki towarzyszące: *Agrostis sfolonifera* 4, *Chara contraria* 16 (1.2), *Chara fragilis* 16, *Equisetum palustre* 1, *Glyceria fluitans* 4, *Polygonum amphibium* f. *terrestre* 5, *Solanum dulcamara* 7.

9. *Elodeetum canadensis* (Table 3, record 4)

The association creates dense, underwater patches, dominated by *Elodea canadensis*. With loose density there appear representatives of the class *Potametea* and in shallow waters also helophytes from the class *Phragmitetea*. Phytocoenoses of *Elodeetum canadensis* occupy muddy bottom of eutrophic waters, developing down to the depth, depended on water transparency.

This association was not noticed in lakes situated on the course of the Cybina River, because of strong water blooms, which prevent the light transparency to the very bottom. It occurred only in rivers – in the Cybina River in Jagodno and in its tributary – Szkutelniak.

Elodeetum canadensis is considered as common and not endangered association both in the Wielkopolska Region, and in Poland (Brzeg and Wojterska 2001, Podbielkowski and Tomaszewicz 2001). However, recently its disappearing from many lakes was observed. It was more and more seldom met also in other water bodies. Because it is a xenospontaneous community, quite a short time occurring in vegetation of our country, probably it will not be considered as worth protecting, even in the case of a direct threat of extinction.

10. *Ceratophylletum demersi* (Table 3, records 5-11)

It is a dense association of submerged plants, which grows on a bottom of waters or floats free in the water column. Characteristic species – *Ceratophyllum demersum* does not have true roots, but only small rhizoids (transformed stems), which enable it for periodical anchorage in the bottom. This species is often accompanied by *C. submersum*, especially in shallow, easily warming reservoirs or in their parts. On the water surface often develops a layer of lemnids, anchored on shoots of *Ceratophyllum*, floating just below the water surface.

It is one of the most common associations of water plants in the Cybina Valley. It occurs in small water bodies of various types (like peat bogs) as well as in preliminary dam reservoirs (Olszak, Browarny, Młyński and Antoninek), bays of the Swarzędzkie Lake and in channels and rivers with slow water flow. It may be considered as an invasion association, which overruns hypertrophic waters. Intensive growth of biomass of plants during summer followed by their decay during fall, causes accumulation of organic sediments. Their mineralisation during the next summer intensifies the process of internal nutrient loading from bottom sediments, which intensifies the eutrophication process (Goldyn 2000).

11. *Ceratophylletum submersi* (Table 3, records 12-15)

It is an alternative association to the aforementioned. *Ceratophyllum submersum* develops often simultaneously with *C. demersum*, replacing it on these stands. During some years seasonal change can be observed – *C. demersum* develops at first, and when temperature of water rises, it is replaced by *C. submersum*. However, occurrence of *Ceratophylletum submersi* may be observed in hot years only, whereas, during cold years *C. demersi* occurs in the same water body (Goldyn 2000). In the patches of the association or just close to them, plants with floating leaves – *Nuphar lutea*, *Nymphaea alba* and *Polygonum amphibium* f. *natans* may develop.

It is an association quite rarely reported from the Wielkopolska Region (**Brzeg** and **Wojterska** 2001). In the Cybina Valley its occurrence in some peat bogs was stated, situated e.g. south from Buszkówiec, between Janków and Góra, between Gruszczyn and Uzarzewo (km 31, 22 and 14, respectively). It occupies also a big area in the shallow southern part of the Swarzędzkie Lake, near the outflow of the Cybina River (km 10). In the years with hot temperature during summertime it was found also in preliminary reservoirs in Poznań (Antoninek, Młyński, Browarny and Olszak) (**Goldyn** 2000).

In the Wielkopolska Region the association has been recognized as endangered with V category, mainly because of rarity of its occurrence. Human activity does not have any negative effect on its occurrence, just the opposite – number of potential places of its occurrence increases as a result of increasing trophic state of waters. Because it is a stenothermal association, observed climate warming will favour its spreading. Characteristic species – *Ceratophyllum submersum* has been added to the regional red list of plants by **Żukowski** and **Jackowiak** (1995) because of a rarity of its occurrence within the Wielkopolska Region. Two other important species were observed in patches of the association: *Nuphar lutea* and *Nymphaea alba*. They belong to partly protected in Poland (Rozporządzenie... 2004).

12. *Myriophylletum verticillati* (Table 3, records 16-17)

Dense stands of submerged plants dominated by characteristic species *Myriophyllum verticillatum* form one-layer association, which occupies almost all the water column. In case of loose density of plants, they develop two or three layers. Submerged plants form two layers, from which the basic one consists of long stems of *Myriophyllum* and the other – form a near the bottom meadow, including among others: *Chara fragilis*, *Ch. contraria* and *Fontinalis antipyretica*. Close to them patches of communities from the alliance *Nymphaeion* occurred, therefore mutual penetration of these phytocoenoses was observed.

The association does not frequently occur in the Wielkopolska Region, because it needs transparent water for the development (**Brzeg** and **Wojterska** 2001). In the Cybina Valley it has been found only in a nameless lake, placed west from the road Biskupice-Jankowo.

Association *Myriophylletum verticillati* has been recognized as endangered in the region with I category, because its development is limited by intensive eutrophication of lakes. The important stonewort species *Chara fragilis* was met in patches of this association. It was published in the red list of algae endangered in Poland (**Siemińska** 1992). Also species from the list of plants protected in Poland – *Utricularia vulgaris* and partly protected – *Nymphaea alba* (Rozporządzenie... 2004) occurred in the association.

13. *Myriophylletum spicati*

This association creates dense, extensive patches dominated by the characteristic species, which is often accompanied by *Ceratophyllum demersum* and other species from the *Potametea* class. It often occupies the entire water column in shallow stands. It prefers eutrophic but not hypertrophic waters, without intensive water blooms. Its occurrence has been stated in two less intensively used fishponds: between Gruszczyn and Uzarzewo and east from the village of Promno. Phytosociological records in the association have not been taken because of limited access to the ponds.

Association of *Myriophyllum spicatum* has been recognized as endangered with category I in the Wielkopolska Region, however it can be found much more often than the previously stated association of *M. verticillatum*. In both cases the threat is caused by eutrophication process of waters, which reduces light access to the bottom, as a result of development of plankton algae. It is a main reason why water-milfoil associations do not occur in lakes situated on the course of the Cybina River.

14. *Nymphaea alba*-*Nuphar lutea* (Table 4)

Characteristic species of this association in principle created separate patches, consisted of one species, which leaves tightly cover the water surface. Because their patches often occur close to each other, transition zones are possible, in which occur together *Nymphaea alba* and *Nuphar lutea*. In running waters this association often creates two layers, as some of leaves are submerged, floating in the water column. The association endures well seasonal, transient drop of water level or even drying up of the habitat. Its terrestrial form was observed in late summer in a nameless lake, situated close to Uzarzewo-Huby. In sheltered bays and small water reservoirs *Nuphar* and *Nymphaea* are often accompanied by pleuston plants from the *Lemnetea* class. In shallow waters including rivers, also helophytes from class *Phragmitetea* can be met. They supplant nymphaeids in the case when waters become very shallow, so they are the next stage of water plants succession. Patches of the association occur at present at the water depth up to 170 cm; however, most frequent depth of their occurrence is between 40 and 120 cm.

The association is considered as quite frequent within the Cybina Valley. It occurs in all natural lakes and in a long section of the Cybina River bed. *Nuphar lutea* is much more frequent than *Nymphaea alba* is. The occurrence of the second one was not noticed in the Góra Lake, despite the fact that some years ago large patches dominated by *Nymphaea alba* were observed there. In the Uzarzewskie Lake it occurs nowadays only in one small phytocoenosis (about 20 m²), despite the fact that during the field studies in 1997 such phytocoenoses occupied large areas. Also in the Swarzędzkie Lake occur fewer patches with *Nymphaea alba* than in 90's. It can be related to deterioration of water quality, especially to decrease of its transparency. It is the main reason, why the association has been considered as endangered in the Wielkopolska Region with V category. Disappearing of patches of this association is observed in many lakes and other water bodies; however, they can be still quite often met. Both characteristic species – *Nymphaea alba* and *Nuphar lutea* are partly protected by law (Rozporządzenie... 2004). Occurrence of phytocoenoses of this association significantly raises natural value of waters in the Cybina Valley (Walory przyrodnicze... 2005).

15. *Potamogeton natans* (Table 5, records 1-2)

Usually it is an association consisting of two layers. First one is dominated by *Potamogeton natans* on the water surface, and the other – by many submerged species from the class *Charetea* and from the alliance *Potamion pectinati*, growing on the bottom and in the water column. In sheltered bays on the water surface also lemniids can be often found, especially *Lemna minor* and *Spirodela polyrhiza*. The association often enters the places occupied by stoneworth associations, as succeeding stage of water plants succession. Its occurrence in a small gravel-lake in Gruszczyń may prove fast eutrophication of this water body. It should be expected that patches of the association

Table 4

Association *Nymphaeo albae-Nupharetum luteae*
Zespół *Nymphaeo albae-Nupharetum luteae*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Succeeding no of record in the table Kolejny numer zdjęcia w tabeli	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Kilometre of the river course Kilometr biegu rzeki	12	10	18	21	12	11	10	18	18	18	25	12	24	24	23	24	25	19	22	22	
Field no of the record Nr zdjęcia w terenie	117	134	166	203	120	128	131	159	160	163	148	116	152	142	154	138	78	62	48	49	
Date – Data	19.08. 2004	19.08. 2004	24.08. 2004	26.09. 2004	19.08. 2004	19.08. 2004	19.08. 2004	24.08. 2004	24.08. 2004	24.08. 2004	24.08. 2004	19.08. 2004	24.08. 2004	24.08. 2004	24.08. 2004	24.08. 2004	19.07. 2004	6.07. 2004	17.06. 2004	17.06. 2004	
Cover of herb layer – c (%) Pokrycie warstwy zielnej – c (%)	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	20
Cover of layer d (%) Pokrycie warstwy d (%)	70	100	95	100	80	70	85	80	90	85	95	80	80	60	90	80	90	85	100	100	
Water depth (cm) Głębokość wody (cm)	0-120	14	120- -160	80- -100	100- -160	50- -200	120	70- -140	60- -150	110- -170	60	0-120	70- -120	50- -120	50- -120	70	100	40	80	80	
Surface of the record (m ²) Powierzchnia zdjęcia (m ²)	80	80	20	15	30	100	32	40	60	100	40	60	80	60	100	80	50	30	32	40	
No of taxa in the record Liczba taksonów w zdjęciu	2	3	2	1	1	1	2	1	2	2	3	3	3	2	2	2	3	4	6	6	
I. Ch. Ass.																					
<i>Nymphaea alba</i>	4.4	4.4	5.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
<i>Nuphar lutea</i>	.	.	1.2	5.5	5.5	4.4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4.4	5.5	5.5	5.5	5.5	5.5	5.5	V

Constancy – Stalność

Table 4 – cont.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
II. Ch. Potametea																						
<i>Ceratophyllum demersum</i>	2.2	4.4	.	.	.	.	2.2	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
<i>Ceratophyllum submersum</i>	.	3.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
<i>Potamogeton crispus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I
III. Ch. Lemnetea																						
<i>Lemna minor</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.1	.	.	I
<i>Spirodela polyrhiza</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	4.4	2.2	I
IV. Ch. Phragmitetea																						
<i>Phragmites australis</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1.2	1.1	+2	.	+	+	.	II
<i>Typha angustifolia</i>	.	.	.	.	.	.	.	.	+	+	+	1.2	1.1	.	.	.	.	.	.	.	.	II
<i>Berula erecta</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+2	+	+	I
<i>Typha latifolia</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+2	.	.	1.2	I

Sporadic species: – Gatunki sporadyczne:

Ch. Phragmitetea: *Equisetum fluviatile* 19, *Rorippa amphibia* 20 (1.2), *Sparganium erectum* 11.

Accompanying species: – Gatunki towarzyszące: *Festuca pratensis* 20.

Table 5
Association *Potametum natantis* and communities from the alliance *Ranunculion fluitantis*
Zespół *Potametum natantis* oraz zespoły należące do związku *Ranunculion fluitantis*

Association – Zespół	<i>Potametum natantis</i>		<i>Beruletum submersae</i>	<i>Hottonietum palustris</i>
Succeeding no of record in the table Kolejny numer zdjęcia w tabeli	1	2	3	4
Kilometre of the river course Kilometr biegu rzeki	14	27	19	31
Field no of the record Nr zdjęcia w terenie	189	14	63	200
Date – Data	26.08.2004	3.06.2004	6.07.2004	24.09.2004
Cover of herb layer – c (%) Pokrycie warstwy zielnej – c (%)	+	+	70	100
Cover of layer d (%) Pokrycie warstwy d (%)	100	95	+	50
Water depth (cm) Głębokość wody (cm)	30	50-100	30	moist wilg.
Surface of the record (m ²) Powierzchnia zdjęcia (m ²)	50	10	30	8
No of taxa in the record Liczba taksonów w zdjęciu	5	7	9	5
Ch. Ass.				
<i>Potamogeton natans</i>	5.5	3.3	.	.
<i>Berula erecta</i>	.	.	5.5	.
<i>Hottonia palustris</i>	.	.	.	5.5
Ch. <i>Potametea</i>				
<i>Elodea canadensis</i>	1.2	2.2	.	.
Ch. <i>Lemnetea</i>				
<i>Lemna trisulca</i>	+	1.1	.	1.1
<i>Lemna minor</i>	.	1.1	+	3.3
<i>Spirodela polyrhiza</i>	.	3.3	+	.
Ch. <i>Phragmitetea</i>				
<i>Phragmites australis</i>	.	1.2	+	.

Sporadic species: – Gatunki sporadyczne:

Ch. *Lemnetea*: *Hydrocharis morsus-ranae* 2.

Ch. *Phragmitetea*: *Alisma plantago-aquatica* 3 (+.2), *Iris pseudacorus* 3, *Mentha aquatica* 3 (1.2), *Oenanthe aquatica* 4 (1.2), *Rorippa amphibia* 4 (1.2), *Sparganium emersum* 3.

Accompanying species: – Gatunki towarzyszące: *Chara vulgaris* 1 (+.2), *Stachys palustris* 3.

Charetum vulgaris, which occur there now, would be soon replaced by phytocoenoses belonging to *Potametea* class, especially by *Potametum natantis*.

In the Cybina Valley the association is rather rare. Only three small patches of it have been found. Except the already mentioned gravel-lake in Gruszczyn, they appeared in a side bay of the Browarny Reservoir and in the lower course of the tributary Szku-telniak. The association is considered as common in the region in eutrophic, small water reservoirs and in bays of the lakes. These waters, however, belong usually to moderately eutrophic, without water blooms.

16. *Hottonietum palustris* (Table 5, record 4)

Mainly submerged leaves of *Hottonia palustris*, with a small share of other amphiphyte species build the association. It occurs in shallow astatic waters with muddy bottom. The characteristic species can tolerate seasonally drying conditions, growing on the surface of bare bottom. In patches of the association, especially during late summer, appear pleuston species, mainly *Lemna minor* and *L. trisulca*.

In the Wielkopolska Region *Hottonietum palustris* occurs quite often in various types of astatic waters. In the Cybina Valley it has been noticed only once, in a small and shallow peat bog (km 31). The association is endangered in the Wielkopolska Region (V category), mainly because of its occurrence in small, seasonal water bodies, in which it is subjected to disappearance as a result of natural plant succession and various human impacts (filling up, permanent drainage, etc.).

17. *Ranunculo-Callitrichetum polymorphae*

It is a one-layer association, built by submerged plants, developing on a sandy or sandy-mud bottom of streams. Besides the dominating *Callitriche cophocarpa* also *Berula erecta* and *Elodea canadensis* in patches of the association can be found. Phytocoenoses of the association are usually small, short, but very dense.

The association was observed in the Cybina River (km 27, 29) and in the Kostrzyński Stream (km 32). It occupied moderately polluted waters, rich in nutrients. Such preferences were confirmed by its occurrence in the Kostrzyński Stream, which received pollution from the town of Kostrzyn (Goldyn and Grabia 1998).

Any phytosociological records of this association have not been mentioned so far from the Wielkopolska Region and probably also from other parts of Poland. It occurs rather rarely and this is the main reason for its recognition as an endangered association (I category).

18. *Beruletum submersae* (Table 5, record 3)

It is an association of submerged plants, which occur in shallow rivers, with slowly flowing water. Dominating species is *Berula erecta*. Near the bank side riparian species start to appear – e.g. *Mentha aquatica*, *Iris pseudacorus*, *Alisma plantago-aquatica*. The association was usually met in a form of small patches in the lower course of tributaries of the Cybina River, on a sandy and sandy-mud bottom. It can be also found in the bed of the Cybina River, in its middle course, on muddy bottom (km 19).

This is an often-found association in the Wielkopolska Region, but so far not described. It has been recognized as endangered with I category, mainly because of lack of information relating to its occurrence. Main threat are periodical melioration activities,

concentrated on dredging the sediments and removing the plants growing in the riverbed. As a result the water flow increases and such association, as *Beruletum submersae* cannot survive.

Discussion

The present study proves that the Cybina Valley is a very valuable area from the natural point of view. It is very important for the citizens of Poznań and some other towns, as it is situated the close to them or partially even within their borders.

Water plants and vegetation developing in the bed of the Cybina River and its tributaries as well as in lakes, reservoirs, ponds and other waters situated in the valley, are characterized by high diversity of species and phytocoenosis. 18 associations, which belong to three classes and six alliances, were found. Most of them occurred in habitats, which were recognized as protected by law (Rozporządzenie... 2001) and 10 of associations were in danger of extinction in the Wielkopolska Region (**Brzeg and Wojterska** 2001). Factors responsible for their disappearing from many water bodies were: short occurrence, ephemeral character of habitats, rarity of occurrence of associations and characteristic species. Endangered with V category were *Lemnetum gibbae*, *Charetum vulgaris*, *Ceratophylletum submersi*, *Nymphaea albae-Nupharetum luteae* and *Hottonietum palustris* and with I category: *Potametum lucentis*, *Myriophylletum verticillati*, *Myriophylletum spicati*, *Ranunculo-Callitrichetum polymorphae* and *Beruletum submersae*. Especially endangered within the Cybina Valley are patches with *Nymphaea alba* of association *Nymphaea albae-Nupharetum luteae* – during the last decade very significant decrease of areas occupied by them happened. The rest of associations, which were not mentioned above, was common in the Wielkopolska Region, often described by many authors (**Brzeg and Wojterska** 2001).

In associations occurred some species, which were included into the national or regional red lists of endangered species: *Chara fragilis* and *C. vulgaris* (**Siemińska** 1992), *Ceratophyllum submersum* (**Żukowski and Jackowiak** 1995) and protected by law – *Utricularia vulgaris* or partly protected: *Nuphar lutea* and *Nymphaea alba* (Rozporządzenie... 2004). It should be emphasized that there occurs also duckweed species – *Lemna gibba*, which is rare in the Wielkopolska Region.

Associations are characterized by the high state of naturalness. With the exception of xenospontaneous association *Elodeetum canadensis* all the others are characterized by natural syngensis (**Brzeg and Wojterska** 2001). However, many of them belong to the category of auxochoric associations, which occupy the habitats influenced by human pressure. It concerns phytocoenoses, which settle over-eutrophicated waters (belonging to the class *Lemnetea* and associations *Ceratophylletum demersi* and *C. submersi* from the class *Potametea*), but on the other hand also overgrow recently made water bodies (like *Charetum vulgaris*, *Potametum pectinati*, *P. natantis*, *P. lucentis*, *Myriophylletum spicati*). Position of the last group of associations, however, is not clear. In fact **Brzeg and Wojterska** (2001) included these associations (except for *M. spicati*) in the category of natural auxochoric associations, but in lakes under strong human impact they show many attributes of natural perdochoric associations. When water transparency decreases, area of their occurrence reduces as well, until finally they disappear entirely or are found only on artificial or transformed places close to the banks (like patch of

Potametum pectinati at the boatyard in the Swarzędzkie Lake). Actually associations stated above, which overgrown man-made waters, should be classified as seminatural, because they consist of local species, originated from primary associations and survive only due to intended, constructive human activity (Faliński 1969). Actual occurrence places of those associations may be recognized as refugia, from where they may spread to lakes, if human activity decreases and water quality improvement happens.

Two associations found in the studied lakes should be recognized as typically perdochoric, disappearing in conditions under strong human impact. These are *Nymphaeo albae-Nupharetum luteae* and *Myriophylletum verticillati*. Even though the second of them was included by Brzeg and Wojterska (2001) to the group of auxochoric associations, in the Cybina Valley it does not show any expansion to recently constructed water bodies. It occurs only in a nameless natural lake without any flow, situated close to the village of Uzarzewo-Huby.

In lakes situated in the course of the Cybina River only one of stated perdochoric associations occurs – *Nymphaeo albae-Nupharetum luteae*. It should be supposed that wide littoral of those lakes was occupied in the past by various submerged plant associations. Lack of them indicated still existing strong human influence on those water ecosystems.

The observed last-years increase of variety of land vegetation on the area of the Cybina Valley (Walory przyrodnicze... 2005) is not accompanied by similar recovery of water plant associations. However, noticed slow improvement of water quality and announced protection and restoration measures of lakes allow to suppose that the process of spontaneous comeback of underwater plants will happen in the close future.

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ZBIOROWISKA ROŚLINNOŚCI WODNEJ DOLINY RZEKI CYBINY

Streszczenie

Badania roślinności wodnej doliny rzeki Cybiny były częścią waloryzacji przyrodniczej przeprowadzonej w 2004 roku. Wykazały one dużą różnorodność oraz bogactwo gatunków i zbiorowisk roślin i zwierząt. W rzekach, jeziorach, zbiornikach zaporowych i innych zbiornikach wodnych stwierdzono występowanie 18 zbiorowisk roślinności wodnej z klas: *Lemnetea*, *Charetea* i *Potametea*. Dziesięć z nich jest zagrożonych w Wielkopolsce. W eutroficznym i hypertroficznym zbiornikach dominują zespoły z klasy *Lemnetea* (tab. 1) oraz *Ceratophylletum demersi* i *C. submersi* (tab. 3). Ostatni z nich, uważany za zagrożony w regionie, jest dość częsty w torfiankach i małych zbiornikach usytuowanych w dolinie Cybiny, zwłaszcza w latach z wysoką temperaturą w lecie.

Większość stwierdzonych zespołów zajmuje siedliska uznane za chronione zarówno przez prawo polskie, jak i europejskie (Rozporządzenie... 2001, Council Directive 92/43/EEC). Większość zespołów z klasy *Potametea* występuje tylko w małych zbiornikach. Unikają one jezior na przepływie Cybiny z powodu zaawansowanego procesu eutrofizacji. Najbardziej niekorzystnym czynnikiem jest małe przenikanie światła, wywołane zakwitami wody. Niewielka poprawa jakości wody obserwowana w ostatnich latach, jak również zapowiadane zabiegi rekultywacyjne jezior pozwalają przypuszczać, że w niedalekiej przyszłości roślinność podwodna powróci do tych jezior. Obecne badania będą wówczas mogły być podstawą do porównań zarówno roślinności, jak i dynamiki sukcesji roślin.

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