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CHARACTERISTICS OF WATER AND WETLAND PLANTS OF THE WATER RESERVOIRS IN THE UMCS BOTANICAL GARDEN IN LUBLIN, POLAND

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A b s t r a c t

The aim of the study was to compile an inventory and determine the ecological characteristics of the spontaneous flora of the restored water reservoirs and their wet banks in the western part of Lublin in the years 1997–2013. The study objects are small reservoirs located at the UMCS Botanical Garden in the Czechówka River valley. These ponds are subjected to strong anthropogenic pressure. 68 plant species from 33 families and 58 genera were recorded in the flora of the ponds and their wet banks. An important feature of the described water bodies is the large proportion of native species (94% of the flora). Cryptophytes and hemicryptophytes as well as biological groups combining the features of hemicryptophytes and cryptophytes are the predominant life forms. Perennials account for 80% of the flora. The ponds and their wet banks are inhabited by 25 medicinal and 19 bee forage plants.

Key words: floristic diversity, urban reservoirs, river valley

Running head: Characteristics of water and wetland plants of the water reservoirs in Lublin

INTRODUCTION

River valleys in the temperate zone are the best model for investigations of species diversity, synanthropisation processes, and flora dynamics. This is associated with the remarkable diversity of the natural habitat and the centuries-long history of human management of riverside areas. River valleys perform the role of ecological corridors [1] and frequently function as diversity centers [2,3]. Particularly important is the susceptibility of riparian ecosystems to invasion of alien plant species [4,5]. In the recent years, considerable attention has been devoted to conservation and protection of urban river valleys [6,7]. An example of such an area is the fragment of the Czechówka River valley with two ponds within the administrative boundaries of the Botanical Garden of Maria Curie-Skłodowska University (UMCS). The ponds are fed with the Czechówka River waters. The river is 18 km long and its catchment covers an area of 78.5 km^2. The Czechówka is a fourth order river and a left tributary of the Bystrzyca River. Although there are many springs in its upper course, their low water discharge provides low amounts of water in both the Czechówka and its tributary, Łazęga River [8]. This situation is related to the lowered underground water table as a result of ongoing exploitation of underground waters by the "Sławinek" water utility (since 1961). The exploitation of underground waters reduced river recharge and simultaneously contributed to water escape from the riverbed [9]. The formation of a depression sink at the end of the 80's of the 20th century led to the periodic disappearance of the Czechówka River and drying out of the ponds in the Botanical Garden. The change in the water relations resulted in the extinction of valuable pond plant and animal species. This fragment of the valley lost its landscape values for over 10 years. In 1996 and 2000, the ponds were revitalised using the latest technology for bottom sealing [10]. Polish flora species and species originating from various regions of the world were gradually introduced to the restored water bodies. Additionally, fragmented communities of spontaneophytes inhabited the ponds with varying intensity.

The aim of the study was to compile an inventory and assess the ecological characteristics of the spontaneous flora of the restored water reservoirs and their wet in the UMCS Botanical Garden in Lublin in the years 1997–2013.

MATERIALS AND METHODS

The characteristics of the study area

The investigated water reservoirs are situated in a historical region of the western part of Lublin, 51°15.629' N, 22°30.975' E. Archival materials show that they were important landscape features in the "Sławinek" health resort at the turn of the 19th and 20th centuries. After the health resort had been closed down (1917), the park with the ponds in Sławinek village became a popular place for rest and recreation among Lublin's inhabitants. In 1965 the UMCS Botanical Garden was established in the area of the health resort park. Plant displays were prepared and the ponds were renovated in 1967 [11]. The ponds were also revitalised in 1996 and 2000. In 1996 the larger 0.8-ha pond was reconstructed (locality A) and its bottom was sealed with a polypropylene matt filled with sodium bentonite. In 2000 the other pond, covering an area of 0.5 ha (locality B), was renovated using the same technology [10]. Sodium bentonite is a sedimentary rock primarily composed of sodium montmorillonite, an alkaline mineral that affects aquatic environments. In the south, the ponds border an expressway (Solidarności Alley) and a housing district behind the road. The south-western part of the pond area borders Warszawska Alley, while the western and northern parts neighbour the terrace slope of the Czechówka River valley. The inclined slope is inhabited by *Acer platanoides* L., *Aesculus hippocastanum* L., *Carpinus betulus* L., *Fraxinus excelsior* L., *Robinia pseudoacacia* L., *Sambucus nigra* L., *Tilia cordata* Mill., and *Ulmus minor* Mill. The surface area of the ponds is 0.8 ha and 0.5 ha, whereas their average and maximum depths are 1.1 m and 1.7 m, respectively (Fig. 1). The ponds are not intended for fishery management. Their high fertility leads to degradation of water quality (blue-green algae), which in turn affects fish populations.

Methods

Floristic explorations of the ponds and their banks (up to a height of 1m) were performed three times in each season (April, June, and August) in the years 1997–2013 in pond A and 2000–2013 in pond B (Table 1). The nomenclature is consistent with that proposed by Index Kewensis [12]. Families and genera as well as species within the genera follow the systematic order. The geographical-historical status of the taxa follows the papers by Chmiel [13] and Jackowiak [14]. The papers of Zając [15] and Zając et al. [16] were consulted in the case of alien species. Classification of life forms (according to Raunkiaer) was found in the work of Zarzycki et al. [17]. Classification into medicinal and bee forage plant groups follows that defined by Podbielkowski and Sudnik-Wójcikowska [18], Kołtowski [19], and Lipiński [20]. The indices of anthropogenic changes in the flora were calculated according to the following formulae (N denotes the number of all taxa investigated) [14,21]:

- the index of synanthropisation = ApNo (number of apophytes) + AlienNo (number of anthropophytes) *100/N,
- the index of apophytisation = ApNo *100/N,
- the index of anthropophytisation = AlienNo *100/N.

The rate of floristic changes in both water bodies was determined using the Jaccard species similarity index [13]. In 2005, 2008, and 2013, the abundance degree was determined for the spontaneous species using a five-grade scale (Table 1).

RESULTS

In total, 68 vascular plant species from 33 families and 58 genera were identified in the ponds (Table 1). A majority of the plants are angiosperms and they account for 98% of all the species. Dicotyledonous plants are represented by 40 taxa (59%) and monocotyledons by 27 taxa (39%). Cryptogamous plants are represented by *Equisetum palustre*. The number of species in the individual families ranged from 1 to 9. Families represented by the largest number of species include Poaceae (9 species), Compositae (7), Cyperaceae (5), followed by Brassicaceae, Boraginaceae, Lamiaceae, Scrophulariaceae and Lemnaceae (3). The three species-richest families constitute 31% of the entire flora (21 species). 18 families were represented by one species only. *Carex* is the species-richest genera (3 species).

The spontaneous flora of the investigated sites is dominated by native species, which account for 94% of the flora (64 species) (Tables 1 and 2). The synanthropisation index is 62%. Lower values (56%) are reported for the apophytisation index. Only four alien species were found. This group includes one archeophyte, *Armoracia rusticana*, and three kenophytes, *Impatiens parviflora*, *Elodea canadensis*, and *Solidago canadensis*. The anthropophytisation index reaches 6%.

The analysed flora is dominated by hemicryptophytes and cryptophytes (37 species, 54% of the flora) (Tables 1 and 2). Other notable biological groups are composed of plants that combine the characteristics of hemicryptophytes and cryptophytes (18 species, 26% of the flora). Perennials account for 80%. The proportion of therophytes is considerably lower (6%), but they dominate over phanerophytes (5%) and chamaephytes (3%). The least important role in this inventory is played by plants exhibiting combined characteristics of chamaephytes, hemicryptophytes and therophytes.

Table 1
List of species and ecological characteristics of spontaneous flora in the water reservoirs and their wet banks in the UMCS Botanical Garden in Lublin

	Family name and species	Year of appearance of species		GHs	LF	UF	Abundance of plants in the years:		
		Locality					2005	2008	2013
		A	B						
	EQUISETACEAE								
1.	*Equisetum palustre* L.	2006	-	Ap	G	-	-	b	c
	CERATOPHYLLACEAE								
2.	*Ceratophyllum demersum* L.	2004	2005	n-Sp	Hy	-	e	e	e
	RANUNCULACEAE								
3.	*Ranunculus repens* L.	2000	2002	Ap	H, Hy	P	e	e	e
	URTICACEAE								
4.	*Urtica dioica* L.	2004	2005	Ap	H	Me	a	b	c
	BETULACEAE								
5.	*Alnus glutinosa* (L.) Gaertn.	1965	2012	Ap	M	Me, P	c	c	c
	CARYOPHYLLACEAE								
6.	*Cerastium holosteoides* Fr.	2007	2007	Ap	C, H	-	-	b	c
	POLYGONACEAE								
7.	*Persicaria maculosa* Gray	2003	2004	Ap	T	-	a	b	b
8.	*Rumex hydrolapathum* Huds.	2000	-	n-Sp	H, Hy	Me, Ne	b	b	b
	SALICACEAE								
9.	*Salix fragilis* L.	1965	1965	Ap	M	Me, Ne, P	a	a	a
	BRASSICACEAE								
10.	*Armoracia rusticana* G. Gaertn., B. Mey. et Scherb.	-	2004	Ar	G	Me	a	b	b
11.	*Cardamine pratensis* L.	2006	-	Ap	H	Me, Ne, P	-	d	d
12.	*Rorippa amphibia* (L.) Besser	2005	2006	Ap	H, Hy	Ne	a	e	e
	PRIMULACEAE								
13.	*Lysimachia nummularia* L.	2006	2006	n-Sp	C	Me, Ne, P	-	d	e
14.	*Lysimachia vulgaris* L.	2010	-	n-Sp	H	Ne, P	-	-	b
	FABACEAE								
15.	*Trifolium repens* L.	2001	2003	Ap	C, H	Me, Ne, P	e	e	e
	HALORAGACEAE								
16.	*Myriophyllum spicatum* L.	2005	2006	n-Sp	Hy	-	b	e	e
	LYTHRACEAE								
17.	*Lythrum salicaria* L.	2001	2003	Ap	H	Me, Ne	c	b	b
	ONAGRACEAE								
18.	*Epilobium hirsutum* L.	2000	2004	Ap	H	Ne, P	c	b	b
19.	*Epilobium roseum* Schreb.	2007	-	n-Sp	H	-	-	a	b
	BALSAMINACEAE								
20.	*Impatiens parviflora* DC.	2005	-	Kn	T	Ne, P	a	c	d
	APIACEAE								
21.	*Aegopodium podagraria* L.	2006	2004	Ap	G, H	Me, Ne, P	a	c	d
22.	*Berula erecta* (Huds.) Coville	2008	-	n-Sp	Hy	-	-	a	b
	BORAGINACEAE								
23.	*Myosotis caespitosa* Schultz	1999	2003	n-Sp	H, T	Ne, P	d	d	d
24.	*Myosotis ramosissima* Rochel ex Schult.	2010	2006	n-Sp	T	Ne, P	-	b	c
25.	*Symphytum officinale* L.	2000	2002	Ap	G, H	Me, Ne, P	b	c	c
	LAMIACEAE								
26.	*Glechoma hederacea* L.	2003	2004	Ap	G, H	Me, Ne, P	d	e	e
27.	*Lycopus europaeus* L.	2001	2003	Ap	H, Hy	Me, Ne	d	b	b
28.	*Prunella vulgaris* L.	2003	2005	Ap	H	Me, Ne	d	e	e
	PLANTAGINACEAE								
29.	*Plantago maior* L.	2002	2004	Ap	H	Me, P	b	b	c

	SCROPHULARIACEAE								
30.	*Scrophularia umbrosa* Dumort.	2008	-	n-Sp	H, Hy	Ne	-	a	b
31.	*Veronica anagallis-aquatica* L.	2005	2008	n-Sp	H	-	a	c	d
32.	*Veronica chamaedrys* L.	2002	2004	Ap	C	Ne	e	e	e
	RUBIACEAE								
33.	*Galium uliginosum* L.	2003	2004	n-Sp	H	-	b	b	c
	CAPRIFOLIACEAE								
34.	*Sambucus nigra* L.	1981	-	Ap	N	Me, Ne, P	a	a	a
	COMPOSITAE								
35.	*Bellis perennis* L.	2002	2004	Ap	H	Me, Ne, P	e	e	e
36.	*Bidens tripartita* L.	2006	2006	Ap	T	Me, Ne, P	-	c	d
37.	*Hieracium caespitosum* Dumort.	2003	2005	Ap	H	-	b	b	c
38.	*Solidago canadensis* L.	2007	-	Kn	G, H	Me, Ne	-	a	b
39.	*Sonchus arvensis* L.	-	2008	Ap	G, H	Ne, P	-	a	b
40.	*Taraxacum officinale* agg. F.H. Wigg.	2001	2003	Ap	H	Me, Ne, P	e	e	e
41.	*Tussilago farfara* L.	2000	2003	Ap	G	Me, Ne, P	e	e	e
	ALISMATACEAE								
42.	*Alisma plantago-aquatica* L.	1998	2001	Ap	Hy	-	c	d	e
43.	*Sagittaria sagittifolia* L.	2004	2006	n-Sp	Hy	-	c	c	c
	HYDROCHARITACEAE								
44.	*Elodea canadensis* Michx.	2006	2008	Kn	Hy	-	-	e	e
	POTAMOGETONACEAE								
45.	*Potamogeton crispus* L.	2004	2005	n-Sp	Hy	-	d	e	e
	LEMNACEAE								
46.	*Lemna minor* L.	1997	2000	Ap	Hy	Me	e	e	e
47.	*Lemna trisulca* L.	2010	-	n-Sp	Hy	-	-	-	e
48.	*Spirodela polyrhiza* (L.) Schleid.	1997	2000	n-Sp	Hy	-	e	e	e
	JUNCACEAE								
49.	*Juncus effusus* L.	2000	2001	Ap	H	-	b	b	b
	CYPERACEAE								
50.	*Bolboschoenus maritimus* (L.) Palla	2006	-	n-Sp	G, Hy	-	-	a	b
51.	*Carex acutiformis* Ehrh.	2000	-	n-Sp	G, Hy	-	c	e	e
52.	*Carex echinata* Murray	2009	-	n-Sp	H	-	-	-	c
53.	*Carex pseudocyperus* L.	2000	-	n-Sp	H, Hy	-	c	c	c
54.	*Scirpus sylvaticus* L.	2000	2004	n-Sp	G	-	c	d	e
	POACEAE								
55.	*Festuca pratensis* Huds.	2006	2006	Ap	H	-	-	e	e
56.	*Festuca rubra* L.	2000	2001	Ap	H	-	e	e	e
57.	*Glyceria maxima* (Hartm.) Holmb.	2000	2002	n-Sp	Hy	-	b	d	e
58.	*Lolium perenne* L.	2001	2004	Ap	H	-	e	e	e
59.	*Molinia caerulea* (L.) Moench	2006	2007	n-Sp	H	-	-	c	e
60.	*Phalaris arundinacea* L.	1998	-	Ap	G, H	-	c	d	d
61.	*Phragmites australis* (Cav.) Trin. ex Steud.	1998	-	Ap	G, Hy	-	d	e	e
62.	*Poa annua* L.	1997	2000	Ap	H, T	-	e	e	e
63.	*Poa trivialis* L.	2003	2005	Ap	H	-	e	e	e
	SPARGANIACEAE								
64.	*Sparganium emersum* Rehmann	2007	-	n-Sp	Hy	-	-	a	c
65.	*Sparganium erectum* L.	1999	2003	n-Sp	Hy	-	b	d	e
	TYPHACEAE								
66.	*Typha angustifolia* L.	2001	2003	Ap	H, Hy	Me	d	e	e
67.	*Typha latifolia* L.	2002	2004	Ap	H, Hy	Me	d	e	b
	IRIDACEAE								
68.	*Iris pseudacorus* L.	1998	2000	n-Sp	G, Hy	Me, Ne, P	b	c	d

Explanations: **GHs** – Geographical-historical status: Ap – apophytes, Ar – archeophytes, D – diaphytes, Kn – kenophytes, n-Sp – non-synanthropic; **LF** – Life forms: M – megaphanerophytes, N – nanophanerophytes, C – chamaephytes, G – geophytes, H – hemicryptophytes, Hy – hydrophytes and helophytes, T – therophytes; **UF** – Usage form: Me – medicinal species, Ne – nectariferous, P – polleniferous; **Abundance**: a –1-5 plants, b – 6-20 plants, c – 21-50 plants, d – 51-100 plants, e – above 100 plants.

Table 2
The share of life forms and geographical-historical groups in the spontaneous flora of the water reservoirs and their wet banks in the UMCS Botanical Garden in Lublin

Life forms		Geographical-historical groups				Total	%
		Spontaneophytes (Sp)		Antropophytes (A)			
		n-Sp	Ap	Ar	Kn		
Phanerophytes	Megaphanerophytes (M)	-	2	-	-	2	3
	Nanophanerophytes (N)	-	1	-	-	1	2
Chamaephytes	Chamaephytes (C)	1	1	-	-	2	3
Hemicryptophytes	Hemicryptophytes (H)	5	14	-	-	20	29
Cryptophytes	Geophytes (G)	1	2	1	-	4	6
	Hydrophytes and helophytes (Hy)	11	2	-	1	13	19
Therophytes	Therophytes (T)	1	2	-	1	4	6
Other forms	C, H	-	2	-	-	2	3
	H, Hy	3	5	-	-	8	11
	H, T	1	1	-	-	2	3
	G, H	-	5	-	1	6	9
	G, Hy	3	1	-	-	4	6
	Total	26	38	1	3	68	100
	%	38	56	2	4	100	-

Explanations of geographical-historical groups: see Table 1.

Fig. 1. View of pond A in the UMCS Botanical Garden in Lublin.

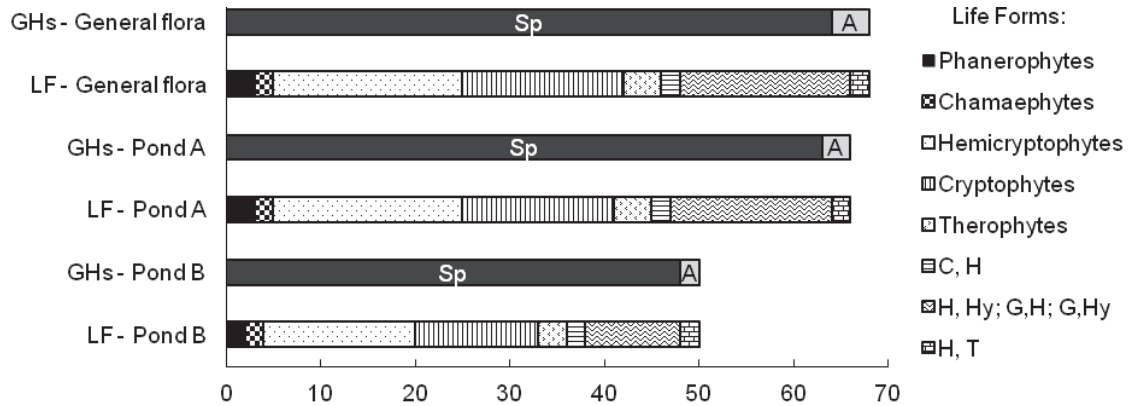

Fig. 2. The share of life forms and geographical-historical groups in the spontaneous flora of pond A and B.

The spontaneous flora of locality A comprises 66 species and locality B has 50 species. 48 taxa are common for the flora of both water bodies (70% of the flora) (Table 1, Fig. 2). The Jaccard species similarity index for the two localities reaches 1.4. 63 spontaneophytes and 3 anthropophytes were reported from locality A, and 48 spontaneophytes and 2 anthropophytes from locality B (Table 1, Fig. 2). The species occurring only in reservoir A (18 species) are characterised by poor growth and spread rates and form small clusters e.g. *Berula erecta*, *Bolboschoenus maritimus*, *Lysimachia vulgaris*, *Rumex hydrolapathum*, and *Scrophularia umbrosa*. They belong to hemicryptophytes and cryptophytes and plants exhibiting combined characteristics – H, Hy; G, H; G, Hy. The share of phanerophytes, chamaephytes, therophytes, C, H, and H, T is comparable in both ponds (Table 1, Fig. 2). *Armoracia rusticana* and *Sonchus arvensis* occur only in locality B (Table 1).

Free-floating plants *Lemna minor* and *Spirodela polyrhiza* were the first to appear on the newly restored ponds; next, the wet zones of the ponds were gradually inhabited by *Alisma plantago-aquatica*, *Phalaris arundinacea*, *Phragmites australis*, *Iris pseudacorus*, *Myosotis caespitosa*, *Sparganium erectum*, *Ranunculus repens*, *Juncus effusus*, *Carex acutiformis*, *Rumex hydrolapathum*, *Glyceria maxima*, and *Symphytum officinale* (Table 1). Massive colonisation by new species was noted three years after revitalisation of the ponds. The intensive colonisation of locality A by spontaneophytes persisted for seven years (2000–2006) and in locality B for only four years (2003–2006) (Fig. 3). In the successive years, the number of new taxa declined considerably, until no new species were reported in the last years of the study.

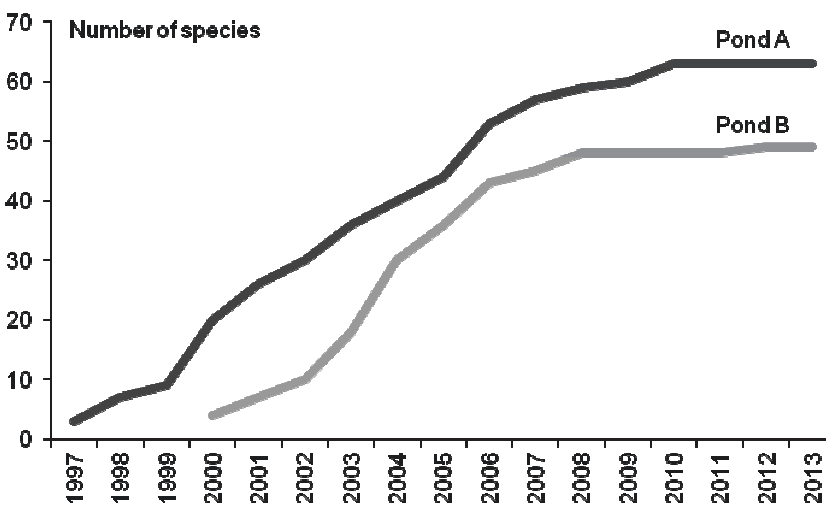

Fig. 3. The rate of spontaneous flora development in the water reservoirs and their wet banks in the UMCS Botanical Garden in Lublin. Pond A – 1997–2013. Pond B – 2000–2013.

Encroaching spontaneophytes spread rapidly in the study area, colonising free spaces in the water bodies and their littoral zones. Based on the analysis of species abundance of the spontaneous flora (Fig. 4), it was found that in 2005 the shares of species in the five consecutive groups (a–e) in the scale were roughly equ-

al, with a slight advantage in the fifth group. In 2008 and 2013, the highest percentage was represented by highly expanding species classified in the fifth group (e – above 100 plants), while in the other groups (b–d) the number of species ranged from 8 to 15 (Table 1, Fig. 4). In 2013 only two phanerophytes, *Salix fragilis* and *Sambucus nigra*, were classified in the first group (a), whereas 30 species (44% of the investigated flora) belonged to the fifth group (e). In the last year of the study, the water bodies were dominated by free-floating plants from the class *Lemnetea* R. Tx. 1955, e.g. *Lemna minor*, *Lemna trisulca,* and *Spirodela polyrhiza*, and submerged plants from the class *Potamogetonetea* R. Tx. et Prsg., e.g. *Ceratophyllum demersum*, *Elodea canadensis*, *Myriophyllum spicatum,* and *Potamogeton crispus*. The littoral zone comprised numerous *Alisma plantago-aquatica*, *Carex acutiformis*, *Glyceria maxima*, *Molinia caerulea*, *Phragmites australis*, *Ranunculus repens*, *Rorippa amphibia*, *Scirpus sylvaticus*, *Sparganium erectum*, and *Typha angustifolia*. The banks of the water reservoirs were dominated by grasses *Festuca pratensis*, *Festuca rubra*, *Lolium perenne*, *Poa annua*, and *Poa trivialis*, with a substantial share of *Bellis perennis*, *Glechoma hederacea*, *Lysimachia nummularia*, *Prunella vulgaris*, *Taraxacum officinale*, *Trifolium repens*, *Tussilago farfara,* and *Veronica chamaedrys*.

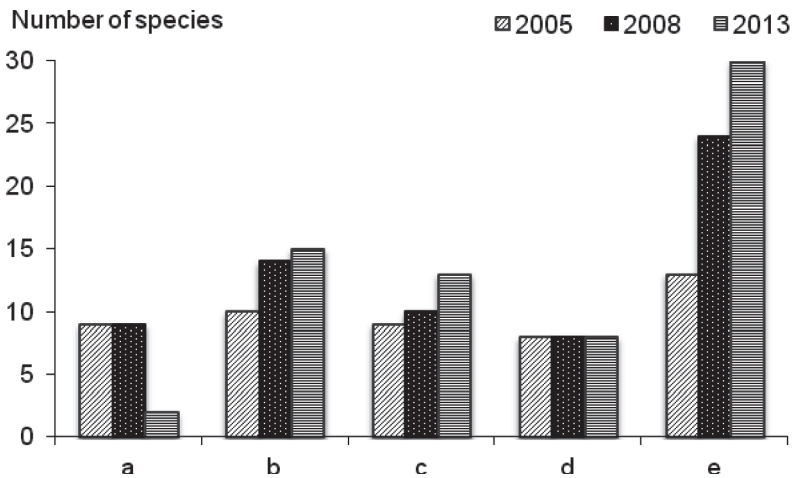

Fig. 4. Changes in the abundance of spontaneous flora in the water reservoirs and their wet banks in the UMCS Botanical Garden in Lublin in the years 2005, 2008, 2013. Abundance: a – 1–5 plants; b – 6–20 plants; c – 21–50 plants; d – 51–100 plants; e – above 100 plants.

The flora of the ponds and their wet zone comprised 25 medicinal plants, 19 nectariferous and polleniferous species, 8 species providing bees with only nectar, and 3 only polleniferous species (Table 1). The lowest number of medicinal plants and bee forage flora was noted among monocots. In contemporary medicine, approximately 15 described taxa are used, e.g. *Alnus glutinosa* and *Iris pseudacorus*. The most valuable melliferous plants strictly associated with aquatic environments include *Cardamine pratensis*, *Epilobium hirsutum*, *Lycopus europaeus*, *Lythrum salicaria*, *Myosotis caespitosa*, *Rorippa amphibia*, *Scrophularia umbrosa*, and *Rumex hydrolapathum*. They are scattered, but their successive flowering between early spring and late summer provides bees with sufficient forage.

DISCUSSION

Small water reservoirs located within urban developments primarily serve an aesthetic and recreational function. However, excessive human interference has disturbed the biotic conditions in such reservoirs. Eutrophication and pollution of surface waters lead to inhibited development of flora and fauna, resulting in their complete elimination from aquatic environments [7,22–24]. Urban water bodies situated in densely built-up areas do not have a high natural value and their floristic composition is very poor. The rush community includes *Phragmites australis* and *Typha angustifolia*, and the submerged vegetation zone comprises *Potamogeton crispus* and *Ceratophyllum demersum* [25,26]. The water table of these reservoirs is dominated by floating plant communities from the class *Lemnetea* R. Tx. 1955, usually by *Lemna minor* often accompanied by *Spirodela polyrhiza*. During the growing season, these communities usually cover the entire water surface, thereby preventing the development of submerged plants and succession of shoreline vegetation.

Urban reservoirs are often maintained in good condition thanks to appropriate treatment practices such as dredging and vegetation spread (overgrowth) control. Examples of such water bodies located within

large urban agglomeration areas include the reservoirs in the left-bank Warsaw [27] as well as in the centre of Szczecin [28] and Poznań [26]. The reservoirs located in the western part of Lublin can be included in this group of water bodies. Despite the similar ecological conditions prevailing in these water bodies, the inventory of spontaneous vegetation in the Lublin reservoirs is four-fold greater than that recorded in the water bodies of Warsaw, Szczecin, or Poznań. A high level of eutrophication in urban reservoirs has an adverse effect on biodiversity. *Ceratophyllum demersum*, *Lemna minor*, *Myriophyllum spicatum*, *Phragmites australis*, *Potamogeton crispus*, *Spirodela polyrhiza*, *Typha angustifolia*, and *Typha latifolia* are characterised by the greatest expansion. These species are often a major component of the spontaneous flora of these water bodies.

Detailed floristic investigations often indicate a high range of anthropophytisation index values. The highest values of this index are reported from the centres of large cities [29]. In contrast, the index values in the Vistula River valley ranged between 11% and 31% [4], whereas at the study sites in the Czechówka River valley the index reached a value of 6%.

Despite human economic activity and natural processes, the areas of big cities still comprise water bodies that have a great natural and landscape value and provide a habitat for medicinal and bee forage plants [7]. These sites are usually under different forms of protection, which ensures their conservation. The Lublin reservoirs analysed comprise 25 medicinal plant species (37% of the spontaneous flora). The share of these plants in the investigated flora is high, considering the size of the study area. For comparison, the vast meadows and peatlands of Łęczna-Włodawa Lakeland near Lublin were reported to comprise 88 medicinal plant species [30], while the entire Lubelszczyzna region – 537 species [31]. Small enclaves of vegetation in cities are a source of valuable and diverse bee forage [32]. Similarly, small plant communities in agricultural landscape, i.e. baulks, mid-field woodlots and fallows, are important refuge areas for forage vegetation [33]. These habitats increase the floristic biodiversity of these areas and simultaneously provide multispecies forage beneficial for bee development. The biotopes analysed comprised 19 bee forage species representing 28% of the flora.

Small water bodies located in the centres of large cities are characterised by strong anthropogenic transformation. They usually comprise poor spontaneous flora typically dominated by several plant species, e.g. *Glyceria maxima*, *Lemna minor*, *Myriophyllum spicatum*, *Phragmites australis*, *Potamogeton crispus*, *Spirodela polyrhiza*, *Typha angustifolia,* and *Typha latifolia*.

CONCLUSIONS

1. Within 16 years, 68 aquatic, marsh, reed, and hygrophilous plants colonised the restored water reservoirs and their littoral zones. Thirty of them spread expansively, forming fragmentary plant communities and thus preventing succession of the other spontaneophytes.
2. The spontaneous flora of the investigated ponds is dominated by native species, which account for 94% of the flora.
3. The relatively rich species composition of the investigated sites is accompanied by a low proportion of anthropophytes, which is implied by the lower anthropophytisation index, compared to reservoirs in other cities.
4. The biological spectrum is characterised by the dominance of perennials (cryptophytes and hemicryptophytes) over the other life forms.
5. The proportion of species in the spontaneous flora of the small water reservoirs in Lublin is four-fold higher than that in similar urban water bodies in Warsaw, Szczecin, or Poznań. A common feature of urban water reservoirs is their poor floristic composition, primarily consisting of several expansive plant species, e.g. *Glyceria maxima*, *Lemna minor*, *Myriophyllum spicatum*, *Phragmites australis*, *Potamogeton crispus*, *Spirodela polyrhiza*, *Typha angustifolia*, and *Typha latifolia* colonising the entire reservoirs.

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Charakterystyka roślin wodnych i wilgociolubnych zbiorników wodnych w Ogrodzie Botanicznym UMCS w Lublinie, Polska

Streszczenie

Celem pracy była inwentaryzacja i charakterystyka ekologiczna spontanicznie wykształconej flory w odtworzonych zbiornikach wodnych i ich wilgotnych brzegach w zachodniej części Lublina w latach 1997–2013. Badane obiekty są niewielkimi zbiornikami położonymi w Ogrodzie Botanicznym UMCS w dolinie rzeki Czechówki. Stawy znajdują się pod silnym wpływem człowieka. We florze zbiorników i na ich wilgotnych brzegach odnotowano 68 gatunków roślin (z 33 rodzin i 58 rodzajów). Istotną cechą opisywanych obiektów jest duży udział gatunków rodzimych (94% flory). Wśród form życiowych dominują kryptofity i hemikryptofity oraz grupy biologiczne łączące cechy hemikryptofitów oraz kryptofitów. Byliny łącznie stanowią 80% flory. Stawy i ich bagniste brzegi stanowią miejsce występowania 25 gatunków roślin o działaniu leczniczym i 19 gatunków roślin pożytkowych dla owadów.

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