# RESPONSE OF AQUATIC VEGETATION TO EUTROPHICATION PROCESSES IN AGRICULTURAL LANDSCAPE EXEMPLIFIED BY THE GEN. D. CHŁAPOWSKI LANDSCAPE PARK

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**Summary.** The presented investigations were carried out within an agricultural landscape in the Wielkopolska Region. Their goal was to analyse changes in aquatic plant communities of various ecosystems (a lake, peat pits, a drainage ditch) during the last thirty-year period. The study showed that in the 1970s 18 plant communities occurred in the water column of the investigated ecosystems. That number decreased by 4 over the last thirty years. 9 plant associations disappeared. Eight among them are endangered in the Wielkopolska Region. The communities that disappeared preferred mostly slightly eutrophicated waters. They belonged to communities threatened with extinction as a result of increasing human pressure. On the other hand, the new associations are indicators of a high nutrient level in waters and nearly all of them belong nowadays to frequently occurring in aquatic environments of the studied area.

Key words: intensive agriculture, freshwater ecosystems, threat, plant communities diversity, transformation of vegetation

#### INTRODUCTION

Aquatic plant communities are the most valuable natural elements of agricultural landscape. They enrich and help preserve biodiversity within areas which are dominated by arable fields. Agriculture intensification, which is the reason of euthrophication processes acceleration, is their main threat.

The presented results of the study cover aquatic environments which are components of the agricultural landscape mosaic within the Gen. D. Chłapowski Landscape Park situated in Southern Wielkopolska. The aim of this study was to detect changes in the plant communities which grew in water columns of various ecosystems in the last 30 years. For many years, the area of the Park has been vulnerable to human pressure that is mainly a consequence of agriculture intensification. The most serious threats, especially for freshwater ecosystems, were concentrations of nitrogen in surface and ground waters which were increasing during the last decades [Bartoszewicz 1994, Arczyńska-Chudy *et al.* 2009].

# MATERIAL AND METHODS

The presented study covered Lake Zbęchy, Wyskoć Watercourse and pit peats located in meadows surrounding the eastern part of the lake and the starting fragment of the watercourse (Fig. 1). In the register of Regional Water Management (Regionalny Zarząd Gospodarki Wodnej) in Poznań (2003), which was done due to the implementation of European Union regulations to Polish law and in compliance with the requirements of Council Directive 91/676/EWG on the protection of waters against nitrogen pollution, Lake Zbęchy is recognised as threatened with excessive nitrates load from agricultural sources and the watershed area of Wyskoć Watercourse is recognized as an area particularly vulnerable to pollution.



Fig. 1. Map of the investigated area

The intensity of anthropogenic influences on freshwater reservoirs in the last 30 years was an effect of agriculture intensification in the 1970s and 1980s, particularly due to the rapid growth in application of artificial fertilisers and to the development of processing industry in 1990s [Ryszkowski 2002]. But there were more threats, such as recreation, angling and incorrect fishing management of the lake (i.e. introduction of amur and silver carp in 1990s) and important habitat changes in the meadows surrounding the water ecosystems. They were connected with reclamation activities which caused drying and acceleration of

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peat mineralisation processes. The result was nutrients leaching from the meadows and their inflow to surface water.

Plant associations which occurred in water columns of the studied ecosystems were distinguished on the basis of 70 phytosociological records, taken according to the commonly used Braun-Blanquet method. The results were compared with the data from 1976–1985 [Gołdyn 1984a, b, and unpublished data]. In that period 91 phytosociological records were taken in plant associations of the same ecosystems.

Plant communities that are specific for both of the investigated periods were valorised regarding to their threat, syngenesis and frequency of occurrence, according to elaboration of Brzeg and Wojterska [2001].

# RESULTS AND DISCUSSION

In 2006–2007 in the water column of the studied ecosystems 14 plant associations occurred. Comparison of these results with the data from 1976–1981 proved a decrease of phytocenotic diversity during the last 30 years. 9 plant communities perished and 5 new appeared (Tab. 1 and 2). As much as 8 out of 9 communities that disappeared between the investigated periods were classified to the group of plant associations endangered in the Wielkopolska Region. They are: *Charetum aculeolatae, Myriophylletum spicati, Myriophylletum verticillati, Nitellopsidetum obtusae, Potametum lucentis, Sagittario-Sparganietum emersi, Stratiotetum aloidis* and a community of *Fontinalis antipyretica*.

Changes rate	1976–1981	2007-2008
Number of associations	18	14
Number of endangered associations	13	8
Number of associations rare in Wielkopolska	4	3
Number of associations rare in Landscape Park area	13	6
Number of perdochoric associations	4	1
Number of associations which disappeared	9	
Number of the new associations		5

Table 1. Changes in aquatic plant associations in the studied ecosystems

Among 18 plant communities that were distinguished in 1976–1981, as many as 13 belonged to endangered and rare in the Landscape Park. At present, there are 8 endangered associations in the water column (of the total number of 14). The number of perdochoric communities decreased from 4 to 1 in the last 30 years. Classification of plant associations regarding to they syngenesis proposed by Brzeg and Wojterska [2001] was used in this study with only one exception (within the investigated area the character of association *Stratiotetum* 

A second at the	Threat, syngenesis,	Occurence		
Association	frequency	1976–1981	2006–2007	
Ceratophylletum demersi	-, NA, P	t	r, t	
Ceratophylletum submersi	V, NA, R	-	t	
Charetum aculeolatae	V, N, R	t	-	
Charetum hispidae	I, N, C	t	t	
Charetum tomentosae	I, N, C	t	t	
Elodeetum canadensis	-, X, C	r	r	
Lemnetum minoris	-, NA, P	-	r, t	
Lemnetum trisulcae	-, NA, C	-	t	
Lemno-Hydrocharitetum morsus-ranae	I, N, C	t	r, t	
Lemno-Utricularietum vulgaris	I, NA, C	t	t	
Myriophylletum spicati	I, N, C	j	-	
Myriophylletum verticillati	I, NA, R	t	-	
Najadetum marinae	I, NA, R	j	j	
Nitellopsidetum obtusae	I, N, C	j	-	
Nupharo-Nymphaeetum albae	V, NP, C	j, r, t	j, r, t	
Polygonetum natantis	-, NA, C	-	t	
Potametum lucentis	I, NA, C	j	-	
Potametum pectinati	-, NA, C	j	j	
Potametum perfoliati	-, NA, C	j	-	
Sagittario-Sparganietum emersi	I, NP, R	r	-	
Stratiotetum aloidis	V, NP, C	t	-	
Zannichellietum palustris	V, N, R	-	j	
Community of Fontinalis antipyretica	I, NP, C	j	-	

Table 2.	Plant	communities	in	the	studied	ecosystems
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Explanations: V – vulnerable associations, I – associations of indeterminate threat, - not threatened associations; N – natural, P – perdochoric, A – auksochoric, X – xenospontanic; P – common, C – frequent, R – rare; j – Lake Zbęchy, r – Wyskoć Watercourse, t – peat pits

*aloidis* was clearly perdochoric). The results of the study indicate that also *Nitel-lopsidetum obtusae* and *Charetum aculeolatae* should be classified as perdochoric associations (i.e. associations disappearing as a result of human pressure intensification).

In the time between the investigated periods 2 associations – Zannichellietum palustris and Ceratophylletum submersi, which are endangered according to Brzeg and Wojterska [2001], appeared. They are indicators of high nutrient levels in waters and their appearance indicates water quality deterioration. The patches of Zannichellietum palustris are occupying only a small area in Lake Zbęchy nowadays. Zannichellia palustris, the species that is specific for the association, rarely occurs in Wielkpolska and is mentioned by Żukowski and Jackowiaka [1995] in the list of endangered and threatened vascular plants.

The reason for the inclusion of the association *Ceratophylletum submersi* to threatened communities was the rarity of its occurrence in the Wielkopolska Region. It was not found in any pit peat in the 80s and only one station of this

association was known in the Park. At present the patches of *Ceratophylletum submersi* are common in all kinds of small water reservoirs. The reason of its wide spreading observed in other parts of Wielkopolska as well as e.g. in the valley of the Cybina River [Gołdyn *et al.* 2005] may be climate warming [Gołdyn 2010]. If this expansion continues, the status of *Ceratophylletum sub- mersi* as an endangered association cannot be maintained.

The response of aquatic plants to the intensification of human pressure and to increase of eutrophication processes was the withdrawal of particularly vulnerable associations. This was visible within all of the studied ecosystems. 90% of the lost associations are plant communities endangered in the Wielkopolska Region. The most valuable among the disappeared communities (due to their rarity in the Landscape Park) were: *Nitellopsidetum obtusae, Charetum aculeolatae* and *Stratiotetum aloidis*. The association *Nitellopsidetum obtusae* dominated the submerged plant belt of Lake Zbęchy during the 1970s, together with the community of *Fontinalis antipyretica*. The decline in these communities caused a reduction in the belt of submerged plants area from 13 to 2 ha [Gołdyn *et al.* 2008]. Similar changes were reported in many Polish lakes for the same reasons [Nagengast and Pełechaty 2001, Solińska-Górnicka and Symonides 2001, Pełechaty and Sugier 2002, Ciecierska *et al.* 2002, Kłosowski *et al.* 2004, Kłosowski *et al.* 2006].

Thirty years ago, patches of the association *Stratiotetum aloidis* were often found in peat pits. Their complete disappearance within the studied area is a result of the eutrophication progress, particularly of the increase of the content of ammonium and sulphides in the water that are toxic to *Stratiotes aloides*. It is probable that these unfavourable changes are caused by acceleration of peat mineralisation on drainage meadows which surround the studied peat pits, and by intensification of meadows management [Gołdyn *et al.* 2008a]. Similar reasons of *Stratiotes aloides* decline were observed by Smolders *et al.* [1996, 2000, 2003] and Lamers *et al.* [2002]. An increase of nutrients content in the water of peat pits caused also the disappearance of the association *Charetum aculeolatae*.

The study of the occurrence of plant communities in running waters carried on by Szoszkiewicz [2004] pointed that it depended very strictly on the trophic status of the watercourses. Communities which are presently occurring in the Wyskoć Watercourse are typical mostly of rivers with poor water quality, rich in nutrients [Gołdyn 2009]. The association *Sagittario-Sparganietum*, sensitive to human pressure, which had dominated in 1970s, disappeared, which was caused by an increase of nitrogen concentration in the water and by changes in physical conditions (decrease of water flow rate, increase of shading, changes in the character of the substrate). Brzeg and Wojterska [2001] included this association in the group of natural perdochoric communities in the classification based on the genesis and response to human impact of plant communities found in Wielkopolska.

Most of the plant associations which disappeared in the last 30 years required average fertility of the water and they are vulnerable to the progress of eutrophication processes. On the contrary, the new associations are typical of rather strongly eutrophic waters. Nowadays all of them, except Zannichellietum palustris, are often found in water environments of the studied area.

## CONCLUSIONS

1. In the 1970s 18 plant communities occurred in the water columns of the studied ecosystems. In the last thirty years their number decreased by 4. 9 plant associations disappeared, among them 7 endangered in the Wielkopolska Region. The most valuable among them (because of their rarity within the Landscape Park area) are: *Nitellopsidetum obtusae, Charetum aculeolatae* and *Stratiotetum aloidis*.

2. 5 new associations have appeared, among them *Zannichellietum palustris* and *Ceratophylletum submersi* which are endangered in Wielkoplska.

3. Most of the lost associations are sensitive to the progress of eutrophication processes.

4. The new associations are typical of rather strongly eutrophic waters. Nowadays all of them, except *Zannichellietum palustris*, are often found in water environments of the studied area.

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## REAKCJA ROŚLINNOŚCI WODNEJ NA EUTROFIZACJĘ ŚRODOWISK WODNYCH W ROLNICZYM KRAJOBRAZIE W OKRESIE OSTATNICH 30 LAT NA PRZYKŁADZIE PARKU KRAJOBRAZOWEGO IM. GEN. D. CHŁAPOWSKIEGO

**Streszczenie.** Prezentowane wyniki badań nad zmianami zespołów wodnej roślinności w ostatnim trzydziestoleciu dotyczą rolniczych obszarów Parku Krajobrazowego im. Gen. D. Chłapowskiego, położnego w południowej Wielkopolsce. Ich celem było określenie przemian roślinności wodnej w różnych ekosystemach (jezioro Zbęchy, torfianki, rów Wyskoć). Badania po raz pierwszy prowadzono w latach 1976–1979, a powtórzono w latach 2006–2007. Obszar parku poddany jest od wielu lat silnej presji antropogenicznej, wynikającej przede wszystkim z intensyfikacji rolnictwa. Najpoważniejsze zagrożenia, szczególnie dla ekosystemów wodnych, związane są z postępującym w ciągu ostatnich dziesięcioleci dużym wzrostem zawartości azotu w wodach powierzchniowych i gruntowych. Badania wykazały, że w latach siedemdziesiątych w toni wodnej badanych ekosystemów występowało 18 zbiorowisk roślinnych. W ostatnim 30-leciu ich liczba zmniejszyła się o 4. Zginęło 9 zbiorowisk, wśród nich 7 zagrożonych w Wielkopolsce. Pojawiło się 5 nowych zespołów. Zespoły utracone w większości wymagają wód o średniej trofii i są wrażliwe na postępującą eutrofizację. Natomiast nowe zespoły są związane z wodami żyznymi, o wysokiej trofii i prawie wszystkie należą obecnie do często spotykanych w środowiskach wodnych badanego obszaru.

Słowa kluczowe: intensywne rolnictwo, ekosystemy wodne, zagrożenie, różnorodność zespołów roślinnych, przemiany roślinności