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DIVERSITY AND DISTRIBUTION OF THE VEGETATION IN A WATER BODY SURROUNDED BY EARTH DYKE

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Summary. Diversity and distribution of plant communities in Lake Czarne near Uścimów in the West Polesie region were studied in order to show structure of the vegetation in a lake surrounded by earth construction. Total 12 plant communities belonging to four phytosociological classes were found in the water body and in the lake margins. The most common plant associations were *Ceratophylletum demersi* (34%), *Nymphaeetum candidae* (31%) and *Phragmitetum australis* (22%). Macrophytes colonized ca. 65% of the lake area to the maximum depth of 4.5 m. Large distribution of submerged aquatic vegetation in the lake was related to high water transparency (2.4–4.5 m). Shannon-Weaver index (H = 1.54) indicated relatively high vegetation diversity. With regard to the vegetation, Lake Czarne was evaluated as mature with respect to succession process and natural in terms of anthropogenic impact. The important reason can be that the earth dyke restrains nutrient supply from the catchment basin and thus it hampers eutrophication.

Key words: aquatic vegetation, biodiversity, catchment area, earth dyke, macrophytes

INTRODUCTION

The lakes in the vicinity of the village Uścimów in the Łęczna-Włodawa Lake District are small, shallow and usually rich in nutrients. One of the lakes in that area, Lake Czarne, is surrounded by the earth dyke [Fijałkowski 1959]. The artificially originated earth construction situated in the catchment basin change hydrologic conditions and, in turn, can influence the functioning of the water body. Despite of the fact that the lake was determined as eutrophic, water transparency, chlorophyll *a* concentration and physical-chemical parameters were evaluated positively in relation to the other lakes in the region [Wojciechowska and Solis 2009, unpubl. data].

Distribution and diversity of aquatic vegetation is often used to evaluation of the ecological status of lake [Rejewski 1981, Ciecierska and Radwan 2000, Ciecierska 2006]. The objective of the present study was to show structure of the vegetation in a lake surrounded by earth dyke and to evaluate quality of macrophyte structure in the water body.

STUDY AREA AND METHODS

Lake Czarne (geographical co-ordinates: 51°29'08" N, 22°56'34" E) is situated in the Łęczna-Włodawa Lake District in the West Polesie region [Kondracki 2002]. The water body is small (24.8 ha) and shallow (max. depth of 10.3 m, in average 3.7 m) according to Water Framework Directive classification [EC Parliament and Council 2000]. The lake is situated in one complex with some ponds and it is often used for fishing.

Phytosociological method of Braun-Blanqet [1951] was employed in the present study. Nomenclature of plant species follows Mirek *et al*. [2002] and nomenclature of syntaxa follows Matuszkiewicz [2001]. The study of vegetation was performed between June and July 2011. Additionally, water transparency was measured with Secchi disc every two weeks between May and July 2011.

Plant communities were recognized in four transects. Each was situated from the lake margin to the maximum depth of macrophyte colonization (Z_{max}). Localization of macrophytes in the lake was measured with GPS receiver (Garmin 60Cx) and then the area occupied by particular plant communities was calculated using MapSource Trip & Waypoint Manager program and bathymetric plan of the lake [Wilgat 1951].

Vegetation diversity and tendency of particular plant communities to dominate vegetation cover was evaluated by Shannon-Weaver index (H) and evenness (E). Calculations were performed with MVSP 3.1 [Kovach 1986–1999].

Evaluation method of anthropogenic changes in the vegetation of a lake ecosystem was employed according to Rejewski [1981]. Colonization index (I_z) was determined as the quotient of the phytolittoral zone area and the water table area limited by an isobath of 2.5 m. Succession index (I_s) reflected developmental stage of vegetation in lake was calculated as the product of H and I_z. Synantropization quotient (W_s) was also used as a measure of anthropogenic impact on vegetation.

RESULTS

Total 12 plant communities belonging to four phytosociological classes were found in the lake. The alliance *Potamion* and the alliance *Nymphaeion*, both from the class *Potametea* (Tab. 1), grouped respectively submerged vegetation and floating-leaved macrophytes. *Ceratophylletum demersi* and *Nymphaeetum candidae* were the most common plant associations in the lake (Fig. 1).

Emergent vegetation was predominated by plant communities from the class *Phragmitetea*. It was the most differential type of vegetation in the water body (Tab. 1). Within this group *Phragmitetum australis* and *Typhaetum angustifoliae* were the most common in the lake (Fig. 1). The lake margins were often occupied by narrow belts of shrubs belonging to the class *Alnetea* and only occasionally by small patches of plant communities from the class *Molinio-Arrhenatheretea* (Tab. 1).

Table 1. Plant communities in Lake Czarne near Uścimów

Vegetation type	Plant communities
Potamion Koch 1926 em. Oberd. 1957 (all.)	*Ceratophylletum demersi* Hild. 1956,
Nymphaeion Oberd. 1953 (all.)	*Nymphaeetum candidae* Miljan 1958, *Potametum natantis* Soó 1923, *Hydrocharitetum morsus-ranae* Langendonck 1935,
Phragmitetea R.Tx. et Prsg 1942 (cl.)	*Phragmitetum australis* (Gams 1927) Schmale 1939, *Typhetum latifoliae* Soó 1927, *T. angustifoliae* (Allorge 1922) Soó 1927, *Scirpetum lacustris* (Allorge 1922) Chouard 1924, *Thelypteridi-Phragmitetum* Kuiper 1957, *Caricetum elatae* Koch 1926,
Molinio-Arrhenatheretea R. Tx. 1937 (cl.)	*Scirpetum sylvatici* Ralski 1931,
Alnetea Br.-Bl. et R. Tx. 1943 (cl.)	*Salicetum pentandro-cinereae* (Almq. 1929) Pass. 1961.

Explanations: all. – alliance, cl. – class.

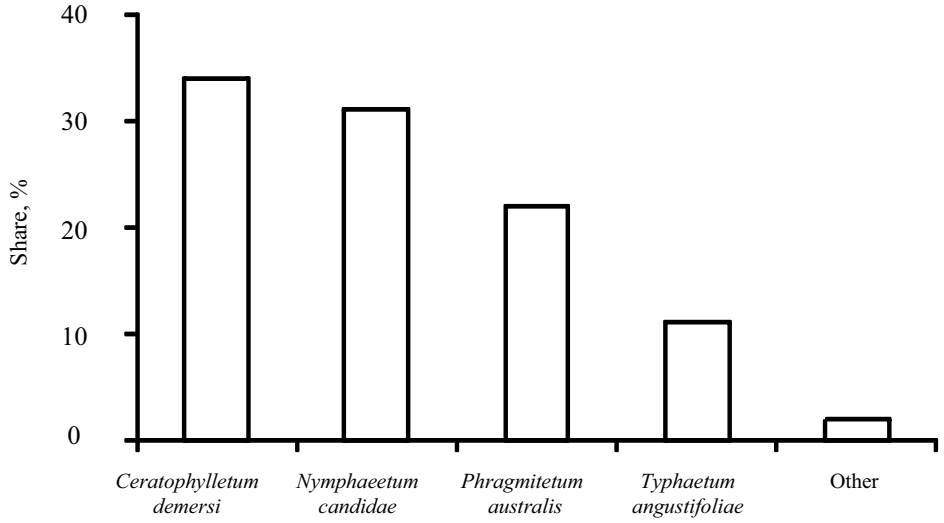

Fig. 1. Vegetation structure in Lake Czarne near Uścimów

The vegetation colonized ca. 65% of the lake area. Maximum depth of macrophyte colonization Z_{max} ranged from 4.4 to 4.8 m and it was 4.5 m in average. Distribution of the submerged vegetation depended on water transparency. Visibility of Secchi disc during the vegetative period ranged from 2.4 to 4.5 m, and it was higher in spring (3.8 m in average), than in summer (3 m).

Vegetation diversity recognized by Shannon-Weaver index was relatively high (H = 1.54). The evenness (E = 0.62) indicated no tendency to strict domination of particular plant communities in the lake (Fig. 1). Colonization index (I_z),

expressed large vegetation distribution, was also high (1.6). Succession index (I_s = 2.5) pointed at mature state with respect to succession of the vegetation and synanthropization quotient (W_s = 0.24) showed natural state in terms of anthropogenic impact.

DISCUSSION

The lakes situated in agricultural landscape are commonly endangered due to nutrient supply originated from the catchment area. The consequences of increased trophy, e.g. high water turbidity, phytoplankton blooms and decline of submerged vegetation, are common in the Łęczna-Włodawa Lake District [Wilgat *et al*. 1991, Wojciechowska and Solis 2009]. However, enhanced eutrophication is not remarkable in some lakes situated in this region.

The results of the study suggest that for the approximately fifty years structure of macrophytes in the lake slightly changed. Supposedly, the area covered by the nymphaeids and elodeids increased; submerged vegetation and floating-leaved spread out in the littoral zone during the last decades [Fijałkowski 1959]. However, these observations did not evidence clearly any changes of the trophic state. One of the plant communities, which likely expanded was *Nymphaeetum candidae*. Characteristic species of this association, the water lily *Nymphaea candida* is quite common in the Polesie region, whereas it has become extinct in many localities in Poland due to eutrophication [Kłosowski 2001, Ejankowski and Małysz 2011].

Current measurements of physical-chemical and biological parameters in Lake Czarne show that this water body was not significantly transformed [unpubl. data]. Large vegetation development, high depth of macrophyte colonization correlated with high water transparency and relatively high vegetation diversity indicate that the trophic state of Lake Czarne is stable, in comparison to other water bodies in the Łęczna-Włodawa region [Sender 2009, Wojciechowska and Solis 2009].

With respect to vegetation cover Lake Czarne is comparable to other lakes only slightly affected or unaffected by human activity [Rejewski 1981]. Distribution of the submerged macrophytes and vegetation diversity in the lake was relatively high, near to the values characteristic for mesotrophic lakes in the Łęczna-Włodawa Lake District [Ciecierska and Radwan 2000].

The reason that Lake Czarne maintains clear-water macrophyte dominated state can be that the water body is surrounded by earth dyke, which limits nutrient supply from the catchment area and hampers eutrophication. Similar effect was observed in Lake Bikcze, after the lake has been surrounded by ditches restrained drainage from the catchment basin into the lake [Wojciechowski *et al*. 1988]. In this case low chlorophyll *a* concentration, relatively high phytoplankton diversity, no phytoplankton blooms were also observed [Czernaś 2009].

The other reason can be that Lake Czarne is a dimictic lake [Radwan and Kornijów 1998]. The bottom sediments are excluded from the mixing during vegetation season, which can affect water transparency and generally lake functioning [Lampert and Sommer 2001]. However, the other dimictic lakes, which are similar in reference to depth and area (e.g. Lake Maśluchowskie, Lake Głębokie), are often disturbed due to nutrient supply [Wojciechowska and Solis 2009, GIOŚ 2010].

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RÓŻNORODNOŚĆ I ROZMIESZCZENIE ROŚLINNOŚCI W ZBIORNIKU WODNYM OTOCZONYM ZIEMNĄ GROBLĄ

Streszczenie. Celem pracy była ocena struktury roślinności w zbiorniku wodnym otoczonym ziemną groblą. Badano zróżnicowanie i rozmieszczenie zbiorowisk roślinnych w Jeziorze Czarnym k. Uścimowa, położonym na Pojezierzu Łęczyńsko-Włodawskim w regionie Polesia Zachodniego. W zbiorniku i w jego strefie przybrzeżnej stwierdzono obecność 12 zespołów roślinnych należących do 4 klas. Najpospolitszymi zbiorowiskami były *Ceratophylletum demersi* (34%), *Nymphaeetum candidae* (31%) i *Phragmitetum australis* (22%). Roślinność pokrywała ok. 65% powierzchni misy jeziornej do głębokości ok. 4,5 m. Rozmieszczenie roślinności podwodnej było związane z dużą przeźroczystością wody (SD średnio 3,8 m). Wskaźnik Shannona-Weavera (H = 1,54) wskazywał na dużą różnorodność roślinności jeziora. Na podstawie zróżnicowania i rozprzestrzenienia zbiorowisk roślinnych Jezioro Czarne można określić jako zbiornik dojrzały w aspekcie zaawansowania rozwoju i naturalny w odniesieniu do oddziaływań antropogenicznych. Istotną przyczyną tego stanu może być fakt, że grobla ziemna otaczająca większą część jeziora ogranicza zasilanie jego wód w związki biogenne pochodzące ze zlewni.

Słowa kluczowe: roślinność wodna, bioróżnorodność, zlewnia, ziemna grobla, jezioro eutroficzne