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LONG TERM CHANGES OF MACROPHYTES STRUCTURE IN THE LAKE MOSZNE (POLESKI NATIONAL PARK)

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Summary. The lake Moszne is located in the Poleski National Park. This is a comparatively small – 17.5 ha and shallow lake – 1 m. In the 1990s it was described as a dystrophic lake. The lake Moszne is one of the most natural valuable objects of this region. The intensity of overgrowing of lakes is not connected with the size of the reservoir, nor with the depth. It mainly depends on climatic conditions, economic and recreational activity, as well as on hydro-technical changes. The aim of the study was the indication of changes in the structure of macrophytes in the lake Moszne as after-effects of the abiotic conditions change. A distinct decrease of the plant association variety occurred in the studied lake, as well as changes in their qualitative composition. The typical associations for poor habitat have retreated. There took place a homogenisation of plant associations. The surface of water vegetation clearly increased in the studied lake. The biomass of macrophytes also showed an increase tendency. Nowadays the structure of vegetation of the studied lake does not show the typical features for dystrophic lakes.

Key words: macrophytes, lake, long term changes, Moszne Lake

INTRODUCTION

The disappearance of lakes is characteristic for the Łęczna-Włodawa Lakeland. At the beginning of 1950's there were 68 lakes with surface areas above 1 ha [Wilgat 1954].

The processes of drying and overgrowing of shallow reservoirs caused that by the end of 20th century there remained 62 lakes in this region. Among them 56 were natural lakes and the remaining ones were turned into retention reservoirs [Chmielewski 2001].

The disappearance of lakes is caused by natural processes, but first of all it is due to human activity, especially through the hydro-technical changes.

The majority of the lakes of Łęczna-Włodawa Lakeland are in various state of overgrowing. The peatbogs surrounding them in great numbers testify to this. The natural character of dystrophic reservoirs was violated. At the end of the 20th century on the Łęczna-Włodawa Lakeland there were 6 mezotrophic lakes, 7 dystrophic ones, 4 eutyrophic with dystrophic features, and the remaining lakes were eutrophic [Radwan *et al.* 1998]. Overgrowing of lakes is one of the most effective processes that cause their shallowing. Very often this process leads to the disappearance of many water reservoirs. The occurrence of gyttja under the layers of peat testifies to this [Okruszko *et al.* 1974].

At present the degree of disappearance of the lakes is diverse. Some of them are in the extreme state of disappearance (Ciesacin, Karaśne), other ones became seriously shallow, gathering on the bottom gigantic quantities of organic matter, among them the lake Moszne.

The intensity of overgrowing of lakes is not connected neither with the size of the reservoir, nor with the depth. It mainly depends on climatic conditions, economic and recreational activity, as well as hydro-technical changes.

The purpose of the study was identification of changes in the structure of macrophytes in the lake Moszne as after-effects of the abiotic conditions change. The lake Moszne is one of the most natural valuable objects of this region [Radwan *et al.* 1995]. However, the growing pace of changes in the structure of vegetation contributed to undertaking this investigation.

STUDY AREA AND METHODS

The lake Moszne is located in the Poleski National Park. It is relatively small – 17.5 ha, and shallow lake, the maximum depth is 1.0 m, and it is typical of this area. The lake is surrounded by a wide belt of plants, composed by transitional moor vegetation. The study was conducted in the whole vegetative season in the year 2008, in 4 transects [Jansen 1977].

In the investigations of water and rushes vegetation the floristic method was used [Braun-Blanquet 1951, Matuszkiewicz 2001]. The phytocenotic differentiation index was used for the qualification of the macrophytes differentiation and of the degree of succession. The index is based on the surface areas of individual associations. Moreover, the Shannon-Weaver index, based on the number of associations creating the phytolittoral, was used [Ciecierska 2008].

At the same time the biomass and the range of macrophytes occurrence were determined according to the Bernatowicz methods [Bernatowicz 1960].

RESULTS AND DISCUSSION

In the 1950s the lake Moszne belonged to the typical dystrophic lakes [Fijałkowski 1960]. It was described as a forest lake, surrounded by extensive peatbogs, with thickets of *Saliceto-Franguletum, Betuletum humilis* and *Cariceto elongatae-Alnetum* covered peatbogs from the northern and eastern side, while from the western side the lake was surrounded by continental type of the transition peatbogs. The whole lake was surrounded by 200 m wide belt of plants, overgrown by associations typical for transition peatbog.

In the littoral zone small patches of *Myriphylleto-Nupharetum* with *Nuphar luteum, Nymphea candida, Potamogeton natans* and *Stratiotes aloides* developed. From the southern, eastern and northern side of the lake they created a compact carpet of plants.

The patches with *Schoenoplectus lacustris* domination covered only small areas.

The bottom of the whole lake was overgrown with *Chara fragilis* and *Ch. intermedia* [Fijałkowski 1960].

Due to the lack of systematic research of macrophytes in the lakes and adjacent areas, it was difficult exactly to trace the changes in their composition as well as directions of the changes. A synthesis of the lake Moszne vegetation was conducted by Fijałkowski [1992]. However, it was a cursory synthesis.

The largest changes in the plant vegetation were caused by variation in water conditions. In the 1980s there occurred a process of lowering of the water level [Chmielewski *et al*. 1992], which was not indifferent for macrophytes.

The lake Moszne belongs to lakes least threatened in terms of hydrobiology [Wilgat 1989, Chmielewski and Radwan 1993]. Based on studies carried out in the 1990s there are still the most valuable species in the lakes Moszne, Długie and Karaśne [Chmielewski and Urban 1993, Sugier and Popiołek 1998].

The quantity and the composition of plant associations have undergone clear changes in the investigated lake Moszne (Tab. 1). Still in the 1990s in the lake were very numerous *Characea* – bioindicators of lakes with clear water. They belong to a group of plants that is very sensitive to changes in habitat conditions. Overgrowing the bottom of a reservoir, they are not only a symptom of good state of the waters, but they also affect the growth and maintenance of waters purity. Among others, they increase the sedimentation of particles from the water to the bottom sediments, thus causing an improvement of the water transparency. For the process of photosynthesis *Characeae* take carbon dioxide up from two-carbonate ions, with intense precipitation of $CaCO_3$ accompanying this process. It causes so-called biological decalcification of waters, with mineral phosphorus being precipitated at the same time. *Characeae* play also the role of an inhibitor of excessive growth of phytoplankton [Pełechaty and Pukacz 2008].

A true feature of associations of *Charetea* class is their ephemeral character – they appear and disappear suddenly, without perceptible changes in the envi-

Table 1. Plant associations in lake Moszne in 1960s, 1990s, and in 2008

Plant association	1960s	1990s	2008
Caricetum gracilis (Graebn. Et Hueck 1931) R.Tx. 1937	+		
Caricetum lasiocarpae Osvald 1923 emend. Oberd. 1957	+	+	+
Caricetum limosae (Paul 1910) Br-Bl. 1921	+	+	+
Caricetum paniculatae Wangerin 1916	+		
Caricetum ripariae Soo 1928	+		
Caricetum rostratae Rubel 1912	+		
Caricetum vesicariae Br-Bl. et Denis 1926	+		
Ceratophylletum demersi Hild. 1956	+		
Charetum aculeolatae (Corillion 1957) Dąmbska 1966		+	
Charetum fragilis Fijałkowski 1960	+	+	
Elodeetum canadensis (Ping. 1953) Pass. 1964		+	
Equisetetum fluviatilis Steffen 1931	+	+	+
Hydrocharitetum morsus-ranae Langendonck 1953	+	+	+
Myriophylletum spicati Soe 1927	+		+
Nupharo-Nymphaeetum albae Tomasz. 1977	+	+	+
Nymphaeetum candidae Miljan 1958	+	+	+
***Phragmitetum australis* (Gams 1927) Schmale 1939**		+	+
Potametum acutifolii Segal 1961		+	
Potametum natantis Soo 1927	+		
Scirpetum lacustris (Allorge 1922) Chouard 1924	+	+	+
Sparganietim erecti Roll 1938		+	
Thelypteridi-Phragmitetum Kuiper 1957			+
Typhetum latifoliae Soo 1927		+	+
Plant association with *Chara delicatula* Ag.		+	
Plant association with *Chara intermediae*	+		
Total	**17**	**15**	**11**

ronment. But in the lake Moszne a tendency of their atrophy has been observed for several years. Therefore the basis of these changes can be related with habitat changes.

At the time of the present study the occurrence of *Characeae* was not affirmed in the investigated lake. *Myriophyllum spicatum* association has replaced them (Tab. 1).

The area covered with submerged macrophytes is increased. Their occurrence is connected with light conditions in the reservoir. Furthermore, as a result of growth of rushes and plants with floating leaves, the area of the phytolittoral also increased (Fig. 1). In 1990s the phytolittoral still occupied 50.3% of the lake surface area, while the emergent macrophytes made up above 63% [Sender 2003]. Nowadays the phytolittoral area in this lake occupies 95%, and the submerged macrophytes make up 70% of the water surface. This is one of the main

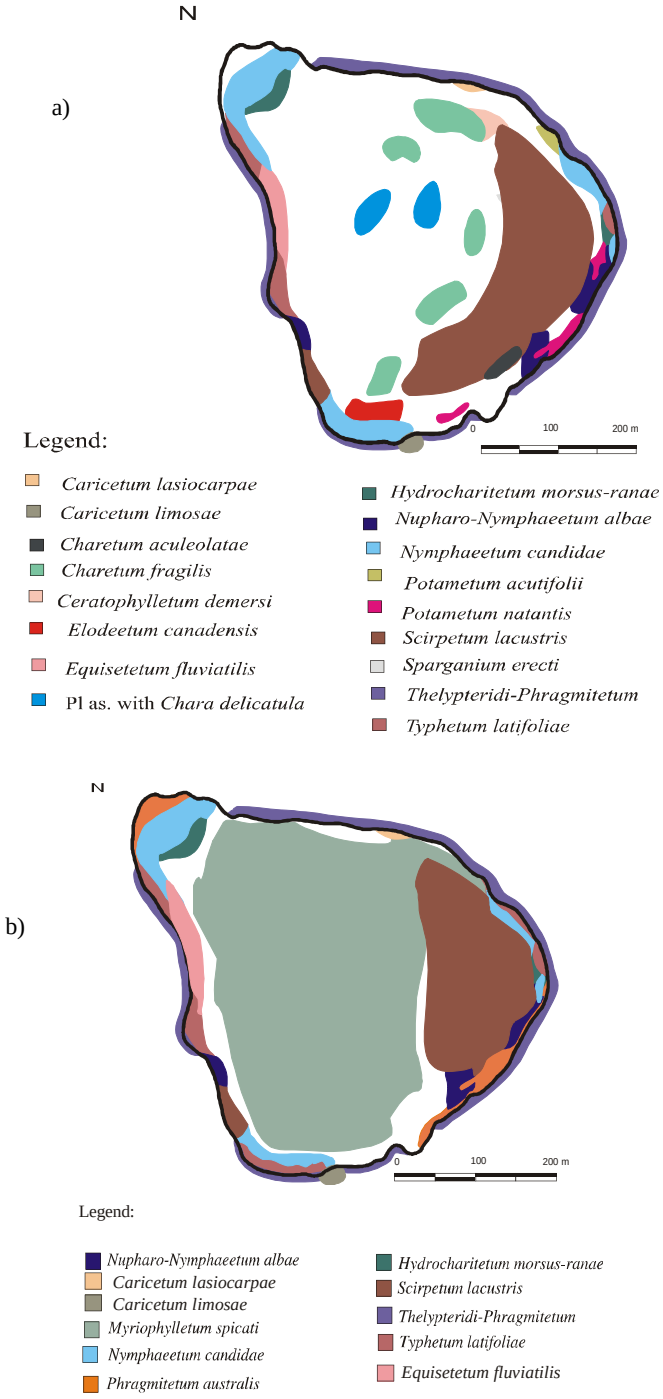

Fig. 1. Distribution of plant communities in lake Moszne: a) in 1990s, b) in 2008

causes of quick shallowing of the reservoir, resulting from sedimentation of organic matter. Probably the phytolittoral had a similar surface area in the 1950s, however the qualitative structure was completely different [Fijałkowski 1960].

At present the variety of plant associations decreased drastically in the lake Moszne (Tab. 2)

Very strong invasion of brushwood associations took place also on the peatbogs surrounding the lake. That is the effect of water level reduction.

Table 2. Percentage share (%) of particular associations in the phytolittoral

Plant associations	Decades	
	1990s	2008
Caricetum lasiocarpae Osvald 1923 Emend. Oberd. 1957	1.8	0.7
Caricetum limosae (Paul 1910) Br-Bl. 1921	1.6	0.8
Charetum aculeolatae (Corillion 1957) Dąmbska 1966	2.8	
Charetum fragilis Fijałkowski 1960	13.9	
Ceratophylletum demersi Hild. 1956	0.8	
Elodeetum canadensis (Ping. 1953) Pass. 1964	2.8	
Equisetetum fluviatilis Steffen 1931	5.6	3
Hydrocharitetum morsus-ranae Langendonck 1953	5.6	2.2
Myriophylletum spicati Soe 1927		45
Nupharo-Nymphaeetum albae Tomasz. 1977	11.8	5
Nymphaeetum candidae Miljan 1958	8.3	9
Phragmitetum australis (Gams 1927) Schmale 1939		5
Potametum acutifolii Segal 1961	2.8	
Potametum natantis Soo 1927	8.3	
Scirpetum lacustris (Allorge 1922) Chouard 1924	8.3	18
Sparganietim erecti Roll 1938	5.6	
Thelypteridi-Phragmitetum Kuiper 1957	6.1	8
Typhetum latifoliae Soo 1927	8.3	4
Plant association with *Chara delicatula* Ag.	5.6	
Phytolittoral (%)	100	100.7

The index of floristic differentiation, being the measure of natural and anthropogenic transformations of littoral vegetation, has undergone very distinct changes in the studied lake. In the 1990s it still attained the value of 2.6, so it allowed the lake to be classified as a mature lake. However, in the year 2008 the index value was only 1.7, which shows that the process of succession is more advanced and the lake belongs already to the category of ageing lakes [Rejewski 1981].

The Shannon-Weaver index also confirms the changes in the qualitative structure of plant associations. In 1950s its value was the highest and has been diminishing in the next decades (Fig. 2).

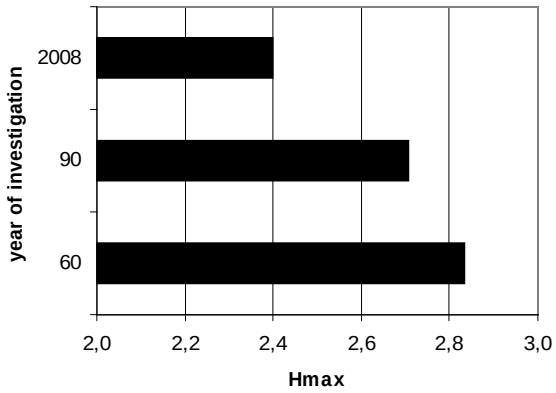

Fig. 2. Shannon-Weaver index

The large phytolittoral area is connected also with high values of the macrophytes biomass. In 1990s the biomass of submerged macrophytes achieved 191 g dw·m^{-2} and *Characeae* predominated. However, in the year 2008, biomass reached as much as 233 g dw·m^{-2}, with *Myriophyllum spicatum* being a dominant.

In 1990s biomass was clearly diverse in littoral and achieved the highest values at the depth of 0.5 m, at present there are no significant differences for various depths (Fig. 3).

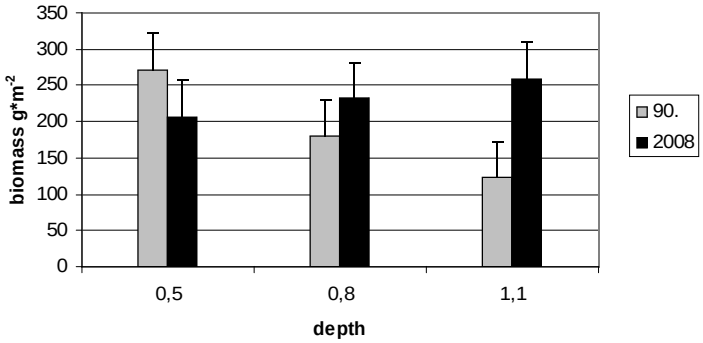

Fig. 3. The biomass of macrophytes at particular depths in lake Moszne

It was affirmed, on the basis of perennial investigations in different lakes, that drastic changes in species composition and biomass of macrophytes took place between eutrophy and hypertrophy. As a result of these changes in hypertrophy lakes there occurred a small number of species and low biomass. Therefore the lake Moszne does not rank in this group, even though the domination of *Myriophyllum spicatum* could suggest that. This reconstruction of species composition is usually connected with changes in chemical properties of water.

Elimination of *Characeae* is very often repercussion of shading by phytoplankton [Ozimek 1990].

The participation of real overgrown surface in relation to the potential surface accessible for macrophytes achieved 90% and this is characteristic for slightly eutrophic lakes [Pieczyńska 1988]. So, the changes in qualitative and quantitative structure of plants in the lake Moszne are caused probably both by abiotic and biotic factors. This structure is subject to fluctuation, but the changes indicate notable growth of water trophy. The changes included the following: impoverishment of the macrophytes variety, especially retreat of *Characea*, high biomass, species composition and significant growth of the phytolittoral surface area.

CONCLUSIONS

A distinct decrease of the plant association variety occurred in the studied lake, as well as changes in their qualitative composition. The typical associations for poor habitat have retreated. There was homogenisation of plant associations.

The area of water vegetation clearly increased in the studied lake. The surface area of the phytolittoral shows variation in the period of several decades. The biomass of macrophytes also showed an increasing tendency.

The structure of vegetation of the studied lake does not show typical features for dystrophic lakes.

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DŁUGOTERMINOWE ZMIANY STRUKTURY MAKROFITÓW JEZIORA MOSZNE (POLESKI PARK NARODOWY)

Streszczenie. Pojezierze Łęczyńsko-Włodawskie to kraina jezior. Na przestrzeni lat jednak obserwuje się ich zanikanie. Zanikanie jezior z jednej strony spowodowane jest procesami naturalnymi, ale także i przede wszystkim działalnością człowieka poprzez zabiegi hydrotechniczne. Zarastanie jezior stanowiło i stanowi najefektywniejszy proces ich spłycania. Proces ten doprowadził do spły-

cenia lub nawet likwidacji wielu dawnych zbiorników wodnych. Świadczy o tym występowanie w spągu gytii jeziornej pod pokładami torfu. Stopień zaniku, aktualnie istniejących jezior jest zróżnicowany. Niektóre z nich znajdują się w stanie krańcowego zaniku inne poważnie zostały wypłycone gromadzącą się na dnie materią organiczną, wśród nich jezioro Moszne, jedno z najcenniejszych przyrodniczo obiektów tego regionu. Rosnące tempo zmian w strukturze roślinności przyczyniło się do podjęcia tego zagadnienia. Celem niniejszej pracy było wskazanie zmian w strukturze makrofitów jeziora Moszne jako następstwa zmiany warunków abiotycznych w tym zbiorniku. W badanym jeziorze nastąpiło wyraźne zmniejszenie się różnorodności zbiorowisk zasiedlających jezioro, jak również zmiany w ich składzie jakościowym. Wyrazem tego było ustępowanie zbiorowisk typowych dla siedlisk mało żyznych, zaś pojawianie się zbiorowisk siedlisk eutroficznych. Nastąpiła homogenizacja zbiorowisk roślinnych. Powierzchnia fitolitoralu oraz biomasa makrofitów wykazywały wyraźną tendencję wzrostową na przestrzeni kilku dekad. Struktura roślinności badanego jeziora nie wykazywała cech typowych dla jezior dystroficznych.

Słowa kluczowe: makrofity, jezioro, długoterminowe zmiany, jezioro Moszne