

THE CHEMICAL COMPOSITION OF BOTTOM SEDIMENTS IN DIFFERENT BIOTIC ZONES OF EUTROPHIC LAKE SUMIN (ŁĘCZNA-WŁODAWA LAKE LAND)

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Summary. In the years 2001-2002 the chemical composition of bottom sediments of eutrophic Lake Sumin, situated in the Łęczna-Włodawa Lakeland was studied. The hydration degree of the sediments, as well as the content of organic matter, silica, biogens (total nitrogen and total phosphorus), micro- and macroelements (Mn, Fe, Ca, Mg, K, Na) were determined. The results indicate that bottom sediments were differentiated in particular zones of the studied lake.

Key words: lake, bottom sediments, zonal differentiation

INTRODUCTION

Bottom sediments constitute an important element of lacustrine ecosystems. They make the origin of nutrients for aquatic plants, participate in the process of change and circulation of the auto- and allochthonic matter in a lake. Bottom sediments reflect the dynamics of the aquatic environment, exert an effect on the conditions of this environment and they may change its properties [Garton *et al.* 1993]. The chemical composition, physical features and thickness of bottom sediments depend on many biotic and abiotic factors, influencing under conditions specific for each lake [Barko and James 1998].

There are a lot of works which apply to bottom sediments, but the chemistry of the lacustrine sediments of the Łęczna-Włodawa Lakeland is relatively little known. In this connection, it was resolved to determine and compare the chemical composition of Lake Sumin bottom sediments in different zones.

STUDY SITE, MATERIAL AND METHODS

Eutrophic Lake Sumin with the surface area of 91.5 ha and the maximum depth of 6.5 m is situated in the Łęczna-Włodawa Lakeland [Radwan and Kornijów 1998]. The coastal zone of the lake is occupied by *Typha angustifolia*, *Phragmites communis* and *Eleocharis palustris*. There are scattered clumps of submerged macrophytes with a do-

minance of *Myriophyllum spicatum*. Nymphaeids are represented mainly by *Nymphaea candida* and *Potamogeton natans*.

The studies of bottom sediments were carried out during two seasons – in spring (May) and autumn (October) in the years 2001-2002. Bottom sediments samples were taken fivefold by means of Kajak's sampler, from their surface layer (15-20 cm), at five stations located in emergent macrophytes zone (stations I and II), submerged macrophytes zone (stations III and IV) and in the middle part of the lake (station V).

Freshly taken samples of bottom sediments were homogenized, and then their humidity was determined. The remaining part of sediments was dried at room temperature, and after grinding to powder it was dried up at 105°C to a constant weight. In so prepared bottom sediments samples determination was made of the content of the following components:

- organic matter – as loss on ignition at 550°C for 2 hours,
- silica (SiO₂) – by the gravimetric method, after the digestion with 10% HCl and incineration of residues at 1100°C,
- total nitrogen (TN) – according to Kjeldahl's method,
- total phosphorus (TP) – by the molybdate method, after the mineralization made with a mixture of HClO₄ and HNO₃,
- Mn, Fe, Ca, Mg, K, Na – by means of spectrophotometry of atomic absorption method (ASA), after the mineralization with using of mixture of HNO₃ and 30% H₂O₂.

The chemical analyses of bottom sediments were performed with prevailing methods applied commonly [Bengtsson and Persson 1978, Januszkiewicz 1978, Sobczyński *et al.* 1996]. All determinations were made in triplicate, and the results were expressed as percentages (%) or mg kg⁻¹ of wet weight (hydration degree) or dry weight (remaining components).

RESULTS AND DISCUSSION

The content of chemical components and the physical properties of bottom sediments of Lake Sumin changed depending on the sampling site. In the zone of emergent macrophytes – in the south-east part of the lake (station I) – the bottom sediments were sandy, solid, weakly hydrated, while sediments originating from the same zone, but taken in the northern part (station II) can be described as mineral-organic. The sediments in the northern part of the lake, from submerged macrophyte zone (station III) were greasy in touch, gelatinous consistence and grey-olive colour. The sediments from the north-east part of the lake (station IV) were black coloured, peaty and contained plant remains. The sediments in the middle part of the lake (station V) were sludgy and greatly hydrated.

The hydration degree of bottom sediments of the studied lake was lower in helophytes zone (55.72%) than among elodeids and in the middle part, where humidity was shaped similarly (~90%, Fig. 1). An important influence on sediments hydration degree was exerted by their mechanical and chemical composition. The sediments hygroscopicity was increased with the increase of organic matter content. The observed dependences are consistent with the results of other authors [Januszkiewicz 1979, Januszkiewicz and Januszkiewicz 1980].

The highest percentage of organic matter was observed in sediments from elodeids zone (63.99%) – three times higher as compared with the emergent macrophyte zone (Fig. 2A). The communities of submerged macrophytes play an important role in promoting sedimentation and after senescence they also constitute a significant origin of organic matter in the sediments [Tomaszewicz 1987, Barko and James 1998]. The relatively high content of organic matter (~45%) in the middle part of the studied lake might have been due to the most intensive accumulation of auto- and allochthonic matter occurring in depression of the lake bottom. According to Januszkiewicz and Samulowska [1978], oxic conditions in the shallow littoral zone favour the intensive decomposition of organic matter, whereas in the middle part of the lake under anoxic conditions and at lower temperature these processes are slower, resulting in faster deposition of detritus and sediment accretion.

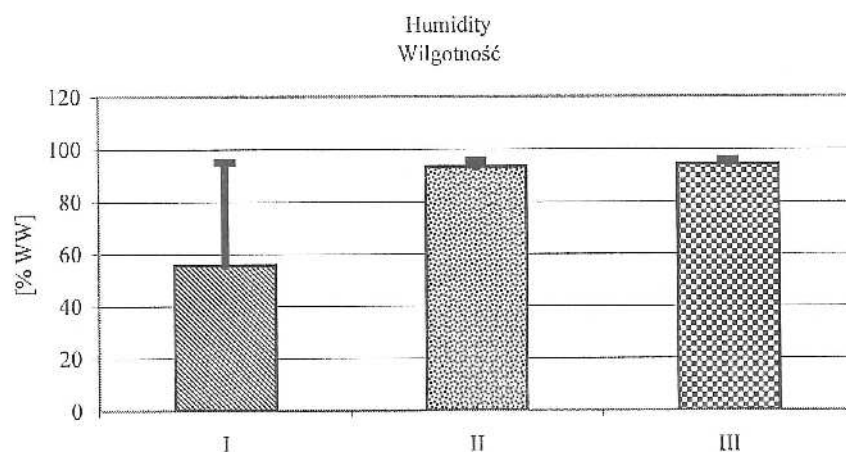


Fig. 1. Humidity of bottom sediments of Lake Sumin – years 2001-2002 (mean values \pm SD);

I – emergent macrophytes, II – submerged macrophytes, III – middle part of the lake

Rys. 1. Wilgotność osadów dennych jeziora Sumin – lata 2001-2002 (wartości średnie \pm SD);

I – roślinność wynurzona, II – roślinność zanurzona, III – śródzieczecze

The spatial distribution of silica shaped inversely in comparison with organic matter. The content of SiO_2 in the sediments among helophytes was more than twice as high as the content for the remaining zones (Fig. 2A). Sandy sediments with a high concentration of silica occur mainly in the coastal parts of the lake and in the middle part of the lake the amounts of silica are usually smaller [Tadajewski 1966, Januszkiewicz and Samulowska 1978].

The content of total nitrogen in the bottom sediments in the zone of submerged macrophytes and in the middle part of the lake ($\sim 20000 \text{ mg kg}^{-1} \text{ DW}$) was twice as high as compared with emergent macrophyte zone ($\sim 9500 \text{ mg kg}^{-1} \text{ DW}$, Fig. 2B). The contribution of TN in bottom sediments in particular zones of the studied lake was shaped similarly to the organic matter content indicating that this element occurred chiefly in the form of organic compounds. A similar relationships was found, e.g., by Januszkiewicz and Samulowska [1978] Januszkiewicz and Januszkiewicz [1980].

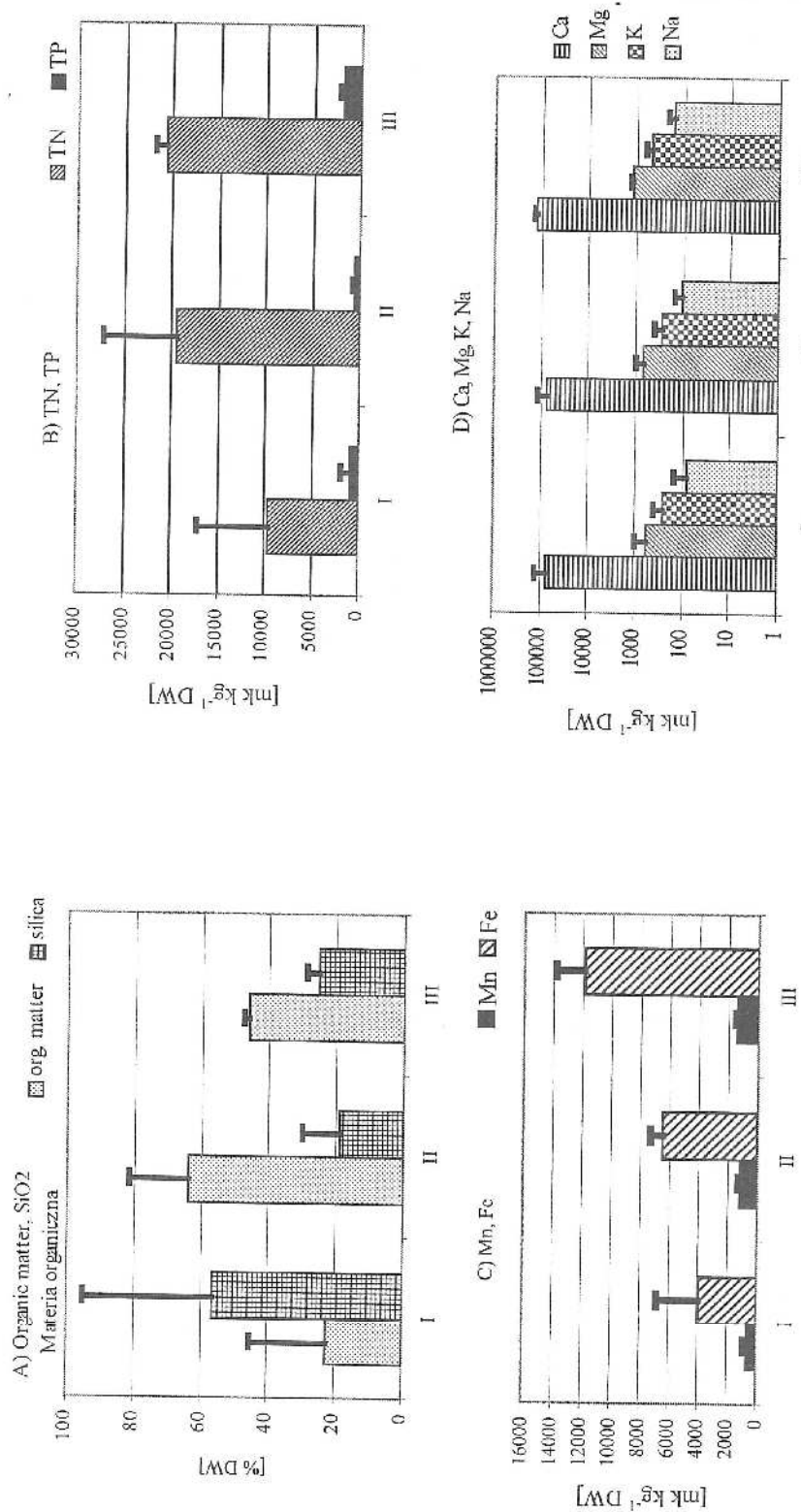


Fig. 2A-D. Content of selected chemical components in bottom sediments of Lake Sumin – years 2001-2002 (mean values \pm SD);
I – emergent macrophytes, II – submerged macrophytes, III – middle part of the lake

Rys. 2A-D. Zawartość wybranych składników chemicznych w osadach dennych jeziora Sumin – lata 2001-2002 (wartości średnie \pm SD);
I – roślinność wynurzona, II – roślinność zanurzona, III – śródlęzie

The lowest content of total phosphorus ($601.56 \text{ mg kg}^{-1} \text{ DW}$) was found in the sediments from submerged macrophyte zone. The sediments in the middle part of the lake contained twice as much of total phosphorus as the sediments from helophytes zone and three times as much as these from elodeides one (Fig. 2B).

The content of manganese in sediments of submerged macrophyte zone and in the middle part of the lake was similar ($\sim 1200 \text{ mg kg}^{-1} \text{ DW}$ and $\sim 1400 \text{ mg kg}^{-1} \text{ DW}$, respectively), while the concentration of this element in sediments among emergent macrophytes was twice as low (Fig. 2C).

Zonal differentiation of iron content in the bottom sediments of the studied lake was found. The biggest amount of iron compounds was contained the sediments in the middle part of the lake ($11898.70 \text{ mg kg}^{-1} \text{ DW}$) and the smallest in the helophytes zone ($2983.26 \text{ mg kg}^{-1} \text{ DW}$, Fig. 2C).

The concentration of alkaline elements in the sediments of the studied lake may be listed in the following sequence: $\text{Ca} > \text{Mg} > \text{K} > \text{Na}$. It can be stated that content of Ca, Mg, K, Na in the sediments from emergent and submerged macrophytes zones shaped similarly. However, in the middle part of the lake it was almost twice as low as compared with the other analysed zones. The concentration of Mg, K and Na showed zonal differentiation tending to increase together with depth growth (Fig 2D). This is most likely due to smaller sorptive capacity of littoral sediments than these from the middle part of the lake and uptake of this nutrients by aquatic plants. In addition, different rates of release of particular elements during the mineralization process of macrophytes cause variations in the chemical composition of the decomposing plant detritus [Pereyra-Ramos 1981].

CONCLUSIONS

Based on the results presented, it can be stated that the bottom sediments of Lake Sumin were zonally differentiated. The richest in silica and the poorest in the remaining analysed components were the sediments among helophytes. The highest content of organic matter and the lowest of silica and total phosphorus was observed in the bottom sediments from submerged macrophyte zone. The sediments from the middle part of lake zone were the most hydrated and contained the biogens, micro- and macroelements in the higher concentrations. Chemical diversity of sediments of the studied lake is connected with the differences in physical, chemical and biological processes in particular zones making various conditions of sediments formation. Besides, the anthropopressure on the aquatic environment is responsible for unfavourable modifications of lacustrine waters quality and, in consequence, marked fluxes of bottom sediments composition.

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KSZTAŁTOWANIE SIĘ SKŁADU CHEMICZNEGO OSADÓW DENNYCH
W RÓŻNYCH STREFACH BIOTYCZNYCH EUTROFICZNEGO JEZIORA SUMIN
(POJEZIERZE ŁĘCZYŃSKO-WŁODAWSKIE)

Streszczenie. W latach 2001-2002 badano skład chemiczny osadów dennych eutroficznego jeziora Sumin, położonego na Pojezierzu Łęczyńsko-Włodawskim. Określono stopień uwodnienia osadów, jak również procentowy udział materii organicznej i krzemionki, zawartość pierwiastków biogennych (azot ogólny i fosfor ogólny) oraz mikro- i makroelementów (Mn, Fe, Ca, Mg, K, Na). Stwierdzono zróżnicowanie składu chemicznego osadów dennych w poszczególnych strefach badanego jeziora.

Słowa kluczowe: jezioro, osady dennie, strefowe zróżnicowanie