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ZOOBENTHOS DIVERSITY IN SIX LAKES OF POLESIE LUBELSKIE REGION (EASTERN POLAND)

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Summary. Six lakes of Polesie Lubelskie (Eastern Poland) differing in development of submerged vegetation were studied during three seasons (spring, summer and autumn) of 2001. There were: lakes Kleszczów, Rotcze and Długie with very well developed macrophytes, lakes Sumin and Głębokie Uścimowskie with poorly developed vegetation and Lake Syczyńskie without submerged vegetation. Studies focused on the domination structure, density and species diversity of bottom fauna. Independently of the season zoobenthos in all studied lakes was predominated by *Chironomidae*. Additionally in spring a very high percentage was reached by *Ceratopogonidae* and *Naididae*, in summer – *Hydrachnidia* and *Ceratopogonidae* and in autumn – *Hydrachnidia, Ephemeroptera* and *Chaoboridae*. Species diversity (Shannon-Wiener index) and density of bottom fauna showed seasonal changes. The highest values of density and Shannon index were observed mostly in autumn.

Key words: lake, zoobenthos, seasonal changes, biodiversity

INTRODUCTION

The diversity of bottom fauna in lakes ecosystems is clearly affected by environmental and feeding conditions, predators pressure, reproduction period, water conditions (such as oxygen content, temperature, turbidity) [Moore 1980, Kajak 1987, 1988, Jonasson 1996]. But usually oxygen concentration and food availability are considered to be the main factors responsible for benthos abundance [Kajak 1966, Giziński 1974]. Because feeding and oxygen conditions are closely related to the season, visible seasonal changes of bottom fauna should be observed. That is why the present paper concerns seasonal differentiation of zoobenthos in shallow lakes.

STUDY AREA, MATERIAL AND METHODS

Bottom fauna was examined in six shallow, polymictic lakes of Polesie Lubelskie (Eastern Poland), differing in the development of submerged vegetation (Tab. 1). Lakes

Table 1. Selected morphometric, physical and chemical parameters of studied lakes [acc. Kornijów *et al.* 2002a]
Tabela 1. Wybrane morfometryczne, fizyczne i chemiczne właściwości badanych jezior

Lake Jezioro	Surface area (ha) Powierzchnia	Maximum depth (m) Maks. głębokość	SD (m)	pH	Conductivity (µs/cm) Przewodnictwo	Total suspension (mg/dm^3) Zawiesina razem	Chlorophyll a (mg/dm^3) Chlorofil	Dissolved oxygen (mg/dm^3) Tlen rozpuszczony	Total P ($\mu g/dm^3$) Razem P	Total N (mg/dm^3) Razem N	PVI (%)
Kleszczów	53.9	2.3	2.3	7.8	263	3.9	5.8	8.0	32.0	3.7	29.3
Łukie	136.7	6.5	2.0	7.3	252	4.4	-	7.2	49.0	3.0	34.5
Rotcze	42.7	4.3	2.5	8.6	306	2.8	12.4	7.6	50.5	3.6	31.2
Sumin	91.5	6.5	1.0	8.2	668	12.2	31.4	5.4	107.0	5.3	3.3
Głębokie Uścimowskie	20.5	7.1	0.9	8.7	413	12.5	58.6	4.8	204.0	4.8	0.8
Syczyńskie	6.0	4.0	0.2	8.8	712	69.9	330.8	4.2	369.5	7.7	0.0

Kleszczów, Rotcze and Długie with dense macrophyte beds, Sumin and Głębokie Uścimowskie with poorly developed vegetation and Lake Syczyńskie without submerged vegetation.

Zoobenthos was collected in spring, summer and autumn during the year 2001. Samples (10 cores of the bottom sediments per 1 sample) were taken from 3 sites (3 samples per one site) in each lake, using a Kajak tube apparatus (surface area 19.6 cm^2). The sediments collected were sieved through a 250 μm mesh size.

The identification of collected macroinvertebrates was made according to Czernowski [1949], Macan [1970], Piechocki [1979] and Wiederholm [1983].

RESULTS AND DISCUSSION

Independently of the season, zoobenthos in all the studied lakes was predominated by *Chironomidae* (Fig. 1, Tab. 2). The mean percentage of midges in particular lakes ranged from 35% (18-57%) in autumn to 57% (42-87%) in spring. Additionally in spring a very high percentage was reached by *Ceratopogonidae* (lakes Rotcze – 50% and Syczyńskie – 33%) and *Naididae* (Lake Długie – 50%). During summer the second dominated taxa were *Hydrachnidia* – 66% (Lake Rotcze) and *Ceratopogonidae* – 37% (Lake Syczyńskie). In autumn apart from *Chironomidae* in particular lakes the following dominated: *Ephemeroptera* – 44% (Lake Rotcze), *Hydrachnidia* in lakes Kleszczów (40%) and Sumin (69%) and *Chaoboridae* – 74% (Lake Syczyńskie). The observed relations in domination structure are common in shallow lakes, usually *Chironomidae* larvae predominating in bottom fauna reached 75-90% of total density [Kajak and Dusoge 1971, Moore 1980, Armitage *et al.* 1995].

Densities of fauna inhabiting bottom sediments were clearly differentiated in particular lakes and seasons (Fig. 2). In most lakes the highest densities of zoobenthos (mean 817 ind. · m^{-2}, range 612-1173 ind. · m^{-2}) were observed in autumn. Only in Lake Długie the peak of bottom fauna was noted in summer (773 ind. · m^{-2}) and in Lake

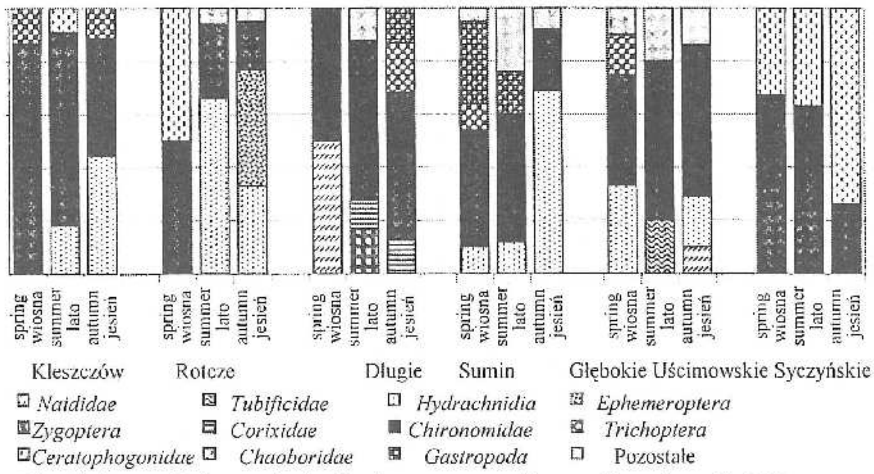

Fig. 1. Seasonal changes in domination structure of bottom fauna in studied lakes

Rys. 1. Sezonowe zmiany w strukturze dominacji fauny na dnie badanych jezior

Table 2. Occurence of bottom fauna in particular seasons in six Polesie Lakes
Tabela 2. Występowanie fauny dennej w poszczególnych porach roku w sześciu jeziorach Polesia

Taxa / Lake Jezioro	Kleszczów			Rotcze			Długie			Sumin			Głebokie Uścimowskie			Syczyńskie		
	spring wiosna	summer lato	autumn jesień	spring wiosna	summer lato	autumn jesień	spring wiosna	summer lato	autumn jesień	spring wiosna	summer lato	autumn jesień	spring wiosna	summer lato	autumn jesień	spring wiosna	summer lato	autumn jesień
NEMATODA															+			
NAIDIDAE					+		+						+	+	+			
TUBIFICIDAE								+			+		+	+	+			
HIRUDINEA								+										
HYDRACHNIDIA		+	+		+	+		+		+	+	+	+	+	+			
EPHEMEROPTERA						+						+						
ANIZOPTERA			+															
ZYGOPTERA									+									
HETEROPTERA																		
Ilyocoris cimicoides													+		+			
CORIXIDAE								+	+									
DIXIDAE								+										
CHIRONOMIDAE	+																	
Ablabesmyia phatta (Eggert)		+			+		+							+				
Procladius sp.	+		+			+		+	+	+	+			+	+		+	
Cricotopus sp. (*silvestris* group)			+							+								
Psectrocladius sp. (*sordidellus* group)	+																	
Chironomus sp.		+	+									+	+	+	+	+	+	+
Cryptochironomus sp.								+			+							
Demicryptochironomus vulneratus (Zett.)													+					
Cryptochironomus viridulus	+						+			+	+		+					
Parachironomus varus (Goetgh.)													+					
Endochironomus albipennis (Meigen)		+	+										+					
Endochironomus impar (Walk.)											+				+			
Glyptotendipes sp.					+										+			
Dicrotendipes sp.					+							+	+	+	+			
Microtendipes sp. (*pedellus* group)	+														+			
Microtendipes rezvoi	+																	
Polypedilum sp.			+			+		+										

contd tab. 2

Phaenopsectra flavipes (Meigen)			+															
Polypedilum sordens (v.d. Wulp)				+									+		+			
Polypedilum sp. (*convictum* group)									+					+	+			
Polypedilum sp. (*nubeculosum* group)											+		+	+	+			
Polypedilum pedestre (Meigen)												+						
Einfeldia sp.			+		+	+		+			+	+	+	+	+			
Pseudochironomus prasinatus (Staeg.)	+											+						
Cladotanytarsus mancus (Walker)	+																	
Paratanytarsus austriacus Kieff.														+				
Tanytarsus sp.						+		+	+		+							
CERATOPOGONIDAE			+	+		+				+						+	+	
CHAOBORIDAE			+								+							+
TRICHOPTERA											+							
Polycentropidae	+		+					+	+			+						
Orthotrichia sp.									+				+					
LEPIDOPTERA											+		+		+			
GASTROPODA																		
Bihynia leachi (Shepp.)														+				
Planorbis planorbis (L.)											+	+						
Valvata piscinalis (O. F. Müller)									+			+						
Number of taxa in particular seasons Liczba taksonów w poszczególnych porach roku	9	4	12	2	6	7	3	11	8	5	13	10	15	12	16	2	3	2
Number of taxa in lakes Liczba taksonów w jeziorach		20			12			18			22			24			4	

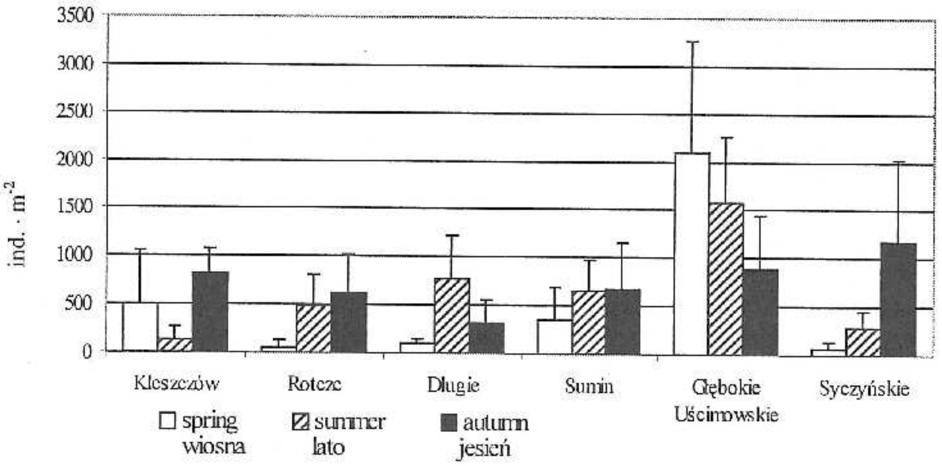

Fig. 2. Seasonal changes of the density of bottom fauna in studied lakes. Vertical bars represent standard deviation

Rys. 2. Sezonowe zmiany gęstości fauny dennej w badanych jeziorach. Paski pionowe oznaczają odchylenie standardowe

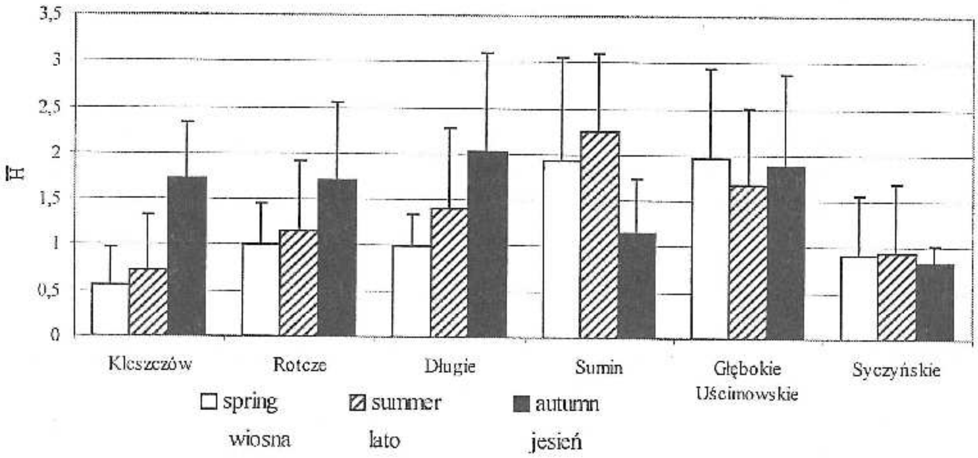

Fig. 3. Seasonal changes of Shannon-Wiener index in studied lakes Vertical bars represent standard deviation

Rys. 3. Sezonowe zmiany wskaźnika Shannona-Wienera w badanych jeziorach. Pionowe paski oznaczają odchylenie standardowe

Głębokie Uścimowskie – in spring (2094 ind. · m^{-2}). Very high densities of bottom fauna were probably caused by food availability. Usually in autumn the sedimentation of detritus and decomposition of macrophytes are very intensive, especially in eutrophic lakes [Kajak 1966, Rasmussen 1985, Kornijów 1988].

Seasonal species diversity of zoobenthos was observed in all studied lakes (Fig. 3). In lakes with well developed macrophytes (Kleszczów, Rotcze and Długie) and in lake Głębokie Uścimowskie with poorly developed vegetation the highest values of Shannon-

Wiener index (H) were noted in autumn (mean 1.84, range 1.71-2.03). In two remaining lakes: Sumin with poorly developed macrophyte beds and Syczyńskie without submerged vegetation, the highest species diversity was observed in summer (H = 2.25 and 0.95 respectively). Changes of density, biomass and species diversity of bottom fauna in particular seasons were probably connected with phenology (length of development cycle, conditions for survival of larvae) of particular benthic taxa [Kajak 1971, Caspers 1984].

Only in Lake Syczyńskie the observed changes among particular seasons were not very clear. Both density and species diversity of bottom fauna showed the lowest and almost equal values in all the studied seasons. Lake Syczyńskie was classified as hypertrophic lake, with a lack of submerged vegetation, very low oxygen content and water transparency. Under such conditions the survival of most benthic taxa is not possible [Kornijów *et al.* 2002b].

CONCLUSIONS

1. Densities and species diversity of bottom fauna showed visible seasonal changes. In most studied lakes the lowest values of these factors were noted in spring, while the highest usually in autumn.

2. Domination structure of zoobenthos was not clearly affected by the season. In all studied lakes and seasons bottom fauna was predominated by *Chironomidae* larvae.

3. The development of submerged vegetation in the studied lakes directly influenced the density and species diversity of zoobenthos. The highest densities and values of Shannon index were observed in lakes with well developed macrophyte beds, the lowest in lake without submerged vegetation.

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RÓŻNORODNOŚĆ ZOOBENTOSU SZEŚCIU JEZIOR POLESIA LUBELSKIEGO (WSCHODNIA POLSKA)

Streszczenie. Analizą objęto zagęszczenie, zróżnicowanie gatunkowe oraz strukturę dominacji fauny dennej, zasiedlającej osady sześciu płytkich, polimiktycznych jezior Polesia Lubelskiego, różniących się stopniem rozwoju roślinności zanurzonej. Były to jeziora: Kleszczów, Rotcze i Długie, w których roślinność pokrywa dno zwartym kobiercem, Sumin i Głębokie Uścimowskie – o kępowym porośnięciu dna przez makrofity, oraz jezioro Syczyńskie – pozbawione roślinności zanurzonej. Próby fauny dennej pobierano w trzech sezonach (wiosna, lato, jesień) 2001 roku. Niezależnie od sezonu, największy udział w faunie dennej miały larwy *Chironomidae*. Ponadto wiosną odnotowano znaczny udział *Ceratopogonidae* i *Naididae*, latem – *Hydrachnidia* i *Ceratopogonidae*, zaś jesienią – *Hydrachnidia, Ephemeroptera i Chaoboridae*. W badanych jeziorach odnotowano również wyraźne sezonowe zróżnicowanie zagęszczenia i różnorodności gatunkowej (wskaźnik Shannona-Wienera) fauny dennej. Przy czym najwyższe liczebności i różnorodność gatunkową zoobentosu stwierdzano przeważnie w sezonie jesiennym.

Słowa kluczowe: jezioro, zoobentos, sezonowe zmiany, różnorodność biologiczna