

SPECIES DIVERSITY OF PROTOZOA (*RHIZOPODA*, *CILIATA*)
ON MOSSES OF SPHAGNUM GENUS IN RESTORATION AREAS
OF THE POLESKI NATIONAL PARK*

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Abstract. Protozoa (*Rhizopoda* and *Ciliata*) were examined on mosses of *Sphagnum* genus in Bubnów and Lejno peatbogs in Poleski National Park (eastern Poland). Six rhizopod taxa and twenty four ciliate taxa occurred. The biggest number, 26 taxa (6 testate amoeba and 20 ciliate) were found in Lejno peatbog, and a little less 17 species (3 and 14, respectively) in Bubnów peatbog. The greatest numbers of testate amoeba occurred in Lejno peatbog. In Bubnów peatbog the numbers of testate amoeba were slightly lower. The numbers of ciliates in the examined areas were similar. In all moss samples bacterivorous protozoan occurred in the highest numbers, while algivorous ones in the lowest.

Key words: peatbogs, moss, restoration, *Ciliata*, *Rhizopoda*

INTRODUCTION

Discoveries made between the 1970's and 1980's, which point to the fundamental importance of micro-organisms (ciliates) in the functioning of water ecosystems, gave rise to increased interest in those protozoa. Those microorganisms are significant consumers of bacteria and phytoplankton, they participate in transformations of organic matter and biogenes [16]. These studies mainly concentrate on benthic and planktonic protozoa, especially in lake and river ecosystems [7,15]. Among the different groups of protozoa, the testate amoebae (*Rhizopoda*) are both abundant and diverse in mosses – including *Sphagnum* – dominated peatland [14]. In addition, testate amoebae produce shells which are well preserved in peat and allow palaeo-environmental reconstruction [9]. Recent studies on the effect of ni-

* The paper was presented and published in the frame of activity of the Centre of Excellence AGROPHYSICS – Contract No.: QLAM-2001-00428 sponsored by EU within the 5FP.

trogen fertilization on microorganisms in *Sphagnum* – dominated peatland have shown that *Rhizopoda* have a control position in the microbial trophic network and react rapidly to environmental changes [5].

Papers concerning the occurrence of protozoa (*Rhizopoda* and *Ciliata*) in peatbog ecosystems are scarce. The world literature on ecological studies includes only a few publications regarding the abundance and taxonomic composition of protozoa in mosses [11,13,17].

The aim of the investigations was to determine the taxonomic composition, abundance and trophic groups of rhizopods and ciliates on mosses of *Sphagnum* genus in a restoration area of the Poleski National Park.

STUDY AREA, MATERIAL AND METHODS

Protozoa (*Rhizopoda* and *Ciliata*) were examined on mosses of *Sphagnum* genus in the Bubnów and Lejno peatbogs in Poleski National Park (eastern Poland). In that area, in 1994, the largest and the most diverse restoration project was launched. In spring, summer and autumn of 2005, from that area eight samples were collected by washing 10 g of wet mass of plant materials, and then flooded with 10 ml of water. Four samples were preserved with Lugol solution. Living observation was used for the taxonomic and trophic identification [3,4]. The determination of protozoa and the calculation of their abundance (individuals per 100 mg w.m.) were conducted according to the methods by Primc-Habdija *et al.* [12]. The frequency of occurrence of particular species was calculated as the percentage of collected samples in which the species occurred. All the species found were classified into four groups as follows: very constant species (i.e. occurring in 61-100 per cent of the samples), constant species (i.e. occurring in 41-60 per cent), accidental species (i.e. occurring in 21-40 per cent of the samples), accessory species (i.e. occurring in less than 20 per cent of the samples).

RESULTS AND DISCUSSION

Species diversity

Six rhizopod taxa and twenty four ciliate taxa occurred in moss. The biggest number, 26 taxa (6 rhizopod and 20 ciliate) were found in the Lejno peatbog and a little less – 17 species (3 and 14, respectively) in the Bubnów peatbog (Tab. 1). The most characteristic species (exclusive species) were found in the Lejno peatbog. In that area *Askenasia sp.*, *Amphileptus pleurosigma*, *Codonella cratera*, *Colpoda steinii*, *Didinium nasutum*, *Paramecium bursaria*, *Platophyra vorax*, *Prorodon sp.*, *Spathidium sensu lato*, *Strombidium viride* (Ciliata) and *Arcella vulgaris*,

Assulina muscorum, *Hyalosphenia papilio* (Rhizopoda) occurred. The ciliates belonging to genus *Chilodontopsis*, *Holophrya* and *Enchelyomorpha* were characteristic of Bubnów peatbog. The species belonging to the orders Pleurostomatida and Prostomatida were observed in various trophic types of European lakes [4,10].

Table 1. The composition and frequency of protozoa found in investigated peatbogs of the Poleski National Park

Taxon	Lejno peatbog	Bubnów peatbog	Frequency (%)	
			Lejno peatbog	Bubnów peatbog
Rhizopoda				
<i>Arcella vulgaris</i>	+		11	
<i>Assulina muscorum</i>	+		5	
<i>Diffflugia oblonga</i>	+	+	89	90
<i>Euglypha sp.</i>	+	+	93	80
<i>Hyalosphenia papilio</i>	+		3	
<i>Nebela longeniformis</i>	+	+	90	75
Ciliata				
<i>Askenasia sp.</i>	+		8	
<i>Amphileptus pleurosigma</i>	+		33	
<i>Chilodontopsis depressa</i>		+		7
<i>Cinetochilum sp.</i>	+	+	58	15
<i>Chlamydonella spp.</i>	+	+	36	76
<i>Codonella cratera</i>	+		6	
<i>Coleps hirtus</i>	+	+	6	5
<i>Colpoda steinii</i>	+		96	
<i>Didinium nasutum</i>	+		2	
<i>Enchelyomorpha vermicularis</i>		+		70
<i>Enchelys sp.</i>	+	+	9	6
<i>Frontonia sp.</i>	+	+	9	1
<i>Gastronauta spp.</i>		+		89
<i>Holophrya sp.</i>		+		8
<i>Monodinium balbiani</i>	+	+	11	3
<i>Paramecium bursaria</i>	+		15	
<i>Paramecium putrinum</i>	+	+	19	15
<i>Platyophyra vorax</i>	+		15	
<i>Prorodon sp.</i>	+		2	
<i>Spathidium sensu lato</i>	+		5	
<i>Strombidium viride</i>	+		12	
<i>Stentor multiformis</i>	+	+	2	2
<i>Trochilia minuta</i>	+	+	11	5
<i>Urotricha sp.</i>	+	+	15	8
Sum	26	17		

A characteristic species *Platyophyra*, usually occurring in the eutrophic Lake Danghu [6], was observed as well. The species belonging to genus *Chilodontopsis* were also observed in strongly contaminated waters [1]. The testate amoebae species

characteristic of Lejno peatbog were also observed in plankton samples in the Parana River (Brasil) [15] and in *Sphagnum*-dominated peatlands in west Europe [9].

In testate amoebae community in the Lejno and Bubnów peatbogs *Diffflugia oblonga*, *Nebela longeniformis* and *Euglypha sp.* were very constant species.

In the Lejno peatbog, in ciliate community, *Colpoda steinii* was a very constant species, *Cinetochilum sp.* were constant taxa, 2 species belonged to accessory taxa, and 16 – to accidental ones. In moss from the Bubnów peatbog – *Chlamydonella spp.*, *Gastronauta spp.* and *Enchelyomorpha vermicularis* occurred also as very constant species, and 11 species belonged to the accidental category (Tab. 1).

Density, domination structure and trophic groups

The greatest numbers of testate amoebae occurred in the Lejno peatbog – 3270 ind.:100 g w.m. of plant materials. In the Bubnów peatbog the numbers of rhizopods was slightly lower and reached 1200 ind.:100 g w.m. The numbers of ciliates in the examined areas were similar. The lowest density was observed in the Bubnów peatbog and it was 2300 ind. 100 g w.m. and the highest – 2423 ind.:100g w.m. – in the Lejno peatbog.

The domination structure of testate amoebae was similar. All of the studied peatbogs were generally dominated by *Diffflugia oblonga*, *Nebela longeniformis* and *Euglypha sp.* constituted >25% of the total numbers. The other species reached as little as <5% of the total numbers (Fig. 1a). According to Vincke *et al.* [17] the moss is dominated by cosmopolitan and ubiquitous taxa.

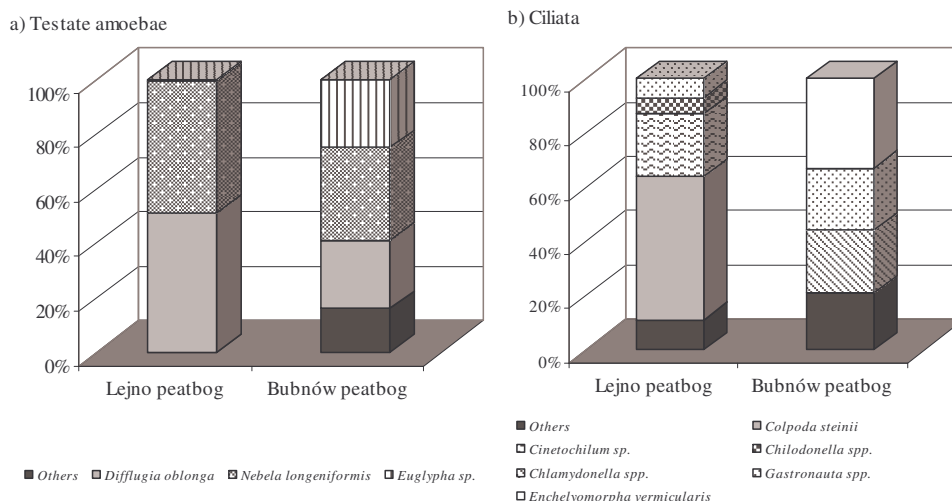


Fig. 1. Domination structure of Testate amoebae (a) and Ciliata (b) found in investigated peatbogs of the Poleski National Park

In the Lejno peatbog *Colpoda steinii* and *Cinetochilum sp.* constituted 53-23% of the total numbers of the ciliates, respectively. Other ciliate taxa reached up to 7% of the total numbers. In the Bubnów peatbog the species belonging to Cyrtophorida (*Chlamydonella spp.* and *Gastronauta spp.*) and Suctorida (*Enchelyomorpha vermicularis*) constituted 23-33% of the total numbers (Fig. 1b). Other ciliate taxa reached up to 4% of the total numbers. The domination of this orders could have resulted from its wide ecological valency [3].

In both peatbogs bacterivorous protozoa occurred in the highest numbers, while algivorous ones in the lowest. Bacterivorous protozoa occurred in the greatest proportion of the total abundance in the Lejno peatbog, where they constituted 60%, and in a smaller proportion – 52% in the Bubnów peatbog. Omnivorous species also occurred in greater numbers, constituting 23 and 20% of the total numbers of protozoa, respectively. Protozoa feeding on mixed food reached the highest proportion in the Lejno peatbog – 10% of the total numbers, while making up 5% of the total community in the Bubnów peatbog. Predatory protozoa constituted from 6 to 9% of the total numbers, while algivorous constituted < 2% of the total abundance (Fig. 2). The slight proportion of algivorous protozoa could have been caused by problems with access to food. Similar relations were observed in periphytic ciliates in littoral zone of lakes of different trophic status in the Łęczyńsko-Włodawskie Lakeland [8], and in moss samples from Gough and Marion Islands [2].

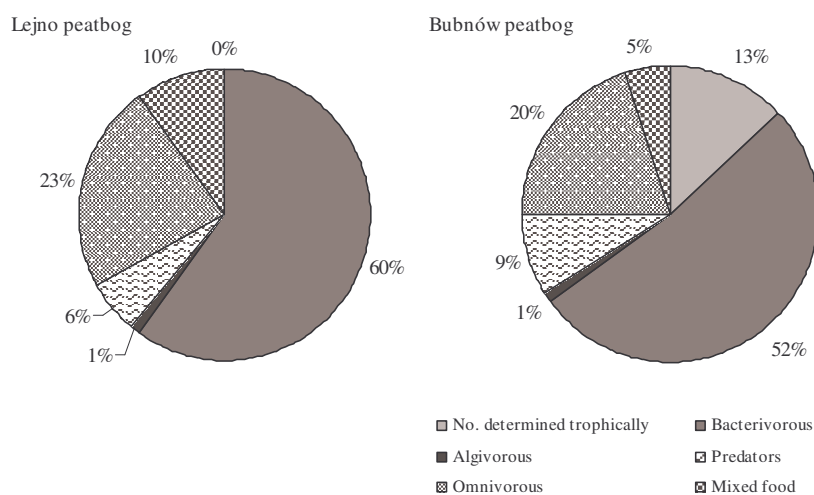


Fig. 2. Trophic groups of protozoan found in investigated areas of the Poleski National Park

CONCLUSION

The biggest number of protozoan species and abundance were found in the Lejno peatbog, a little less in the Bubnów peatbog. The moss was dominated by cosmopolitan and ubiquitous taxa. Bacterivorous protozoa occurred in the highest numbers, while algivorous ones in the lowest. Therefore, it can be supposed that protozoa become a significant link in the flow of matter and energy between bacteria and higher invertebrates in those very specific microhabitats.

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KSZTAŁTOWANIE SIĘ RÓŻNORODNOŚCI GATUNKOWEJ
PIERWOTNIAKÓW (*RHIZOPODA*, *CILIATA*)
NA MCHACH Z RODZAJU *SPHAGNUM* W RENATURALIZOWANYCH
OBSZARACH POLESKIEGO PARKU NARODOWEGO

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Streszczenie. Celem pracy była analiza składu gatunkowego, liczebności oraz struktury troficznej pierwotniaków zasiedlających mchy z rodzaju *Sphagnum* na wybranych obszarach Poleskiego Parku Narodowego poddanych w latach 90-tych zabiegom renaturalizacji. Fauna pierwotniaków charakteryzowała się znacznym bogactwem gatunkowym (od 17 gatunków na obszarze Bagna Bubnów do 26 gatunków na obszarze torfowiska Lejno). Orzęski występowały w podobnych liczebnościach, korzenionózki natomiast wyraźnie wyższe liczebności osiągały na obszarze torfowiska Lejno. Stwierdzono również charakterystyczne proporcje między gatunkami pierwotniaków występujących w mchu. Zaledwie trzy gatunki: *Colpoda steinii*, *Enchelyomorpha vermicularis* i *Cinetochilum sp.* występowało w bardzo dużych ilościach; inne reprezentowane były przez pojedyncze osobniki. W zespołach pierwotniaków najczęściej występowało gatunków bakteriożernych, najmniej zaś gatunków glonożernych.

Słowa kluczowe: renaturalizacja, torfowiska, mech, korzenionózki, orzęski