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ZOOBENTHOS COMMUNITIES FROM PEAT BOG POOLS OF ROZTOCZE NATIONAL PARK: STRUCTURE, SEASONAL VARIATION, ENVIRONMENTAL FACTORS

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Summary. The taxonomic structure and abundance of zoobenthos inhabiting peat bog pools on raised bogs, transitional bogs and fens were investigated on the area of Roztocze National Park. Studies were conducted with regard to environmental parameters specific for a given peat bog pool. Total number of benthic taxa was low (from 5 to 10 taxa dependently on peat bog pool) typical for shallow lakes with patchy vegetation cover. Densities of zoobenthos ranged from 264 to 2244 ind. m^{-2} and showed visible seasonal variability, but observed differences were not significant. Independently on the peat bog pool, zoobenthos community was dominated by larvae of Chironomidae, which amounted from 13 to 100% of total density of bottom fauna.

Key words: bottom fauna, macroinvertebrates, peat bog pool, small water bodies

INTRODUCTION

On many peatlands, a patterned landscape is formed by clusters of open-water pools enclosed by the peat of surrounding terrestrial and semi-aquatic habitats [Belyea and Lancaster 2002]. Peat bog pools are characterized by microhabitats differing in environmental conditions such as water level, physico-chemical parameters, vegetation and substrates. The variations in size and stability of pools may have profound effects on the aquatic invertebrate species associated with them, which may arise as differences in size [Larson and House

1990; Foster 1995], community structure [Schneider and Frost 1996], physiological tolerance, life history modifications and dispersal patterns of the species [Williams 1997, Downie *et al*. 1998].

Most of previous studies on the relations between environmental variables and macroinvertebrates focused on specific groups of macrofauna such as Coleoptera, Heteroptera, Odonata [Downie *et al*. 1998, Drinan *et al*. 2013], and usually consider raised bog ecosystems [van Duinen *et al*. 2006, Hanningan and Kelly-Qiunn 2012]. However there is a general lack of studies on peatbog macrofauna under different trophic conditions.

This paper constitutes a comparative study of the structure of bottom fauna in peat bog pools on different trophic conditions. The specific goals of the study were to: a) determine taxonomic composition and abundance of bottom fauna in pools located on raised bogs, transitional bogs and fens; b) describe seasonal variability within and between studied peat bog pools; c) evaluate the influence of environmental parameters on the abundances and species richness of bottom fauna in types of peat bog pools.

STUDY AREA, MATERIAL AND METHODS

Studies were conducted within six peat bog pools (P) situated on different types of peatbog ecosystems: raised bogs - RB (Międzyrzeki-P1_RB, Tory I-P2_RB), transitional bogs – TB (Kosobudy-P1_TB, Kruglik-P2_TB) and fens –F (Tory II-P1_F, Tory III las-P2_F) on the area of Roztocze National Park (eastern

Table 1. Physical and chemical characteristic of studied peat bog pools (mean values May-October 2012, ±SD)

Specification	P1_RB	P2_RB	P1_TB	P2_TB	P1_F	P2_F
pH	4.6 ±0.9	6.1 ±0.8	4.3 ±0.6	4.9 ±0.7	7.6 ±0.7	7.7 ±0.9
Conductivity, µS cm^{-1}	62 ±12	108 ±91	51 ±9	54 ±39	276 ±78	221 ±40
Dissolved, oxygen mg dm^{-3}	3.3 ±1.7	6.8 ±2.4	5.6 ±2.7	9.8 ±3.2	8.1 ±3.4	4.6 ±1.5
$N\text{-}NO_3$, mg dm^{-3}	0.76 ±0.07	0.87 ±0.71	1.06 ±0.33	1.04 ±0.33	0.39 ±0.10	0.61 ±0.38
$P\text{-}PO_4$, mg dm^{-3}	0.04 ±0.02	0.27 ±0.17	0.14 ±0.21	0.017 ±0.006	0.04 ±0.04	0.049 ±0.082
TP, mg dm^{-3}	0.10 ±0.09	0.39 ±0.23	0.77 ±0.35	0.17 ±0.13	0.28 ±0.24	0.11 ±0.08
Chl *a*, µg dm^{-3}	25.4 ±22.5	76.4 ±105.6	71.4 ±32.3	191.3 ±256.9	9.08 ±5.1	10.6 ±12.8
TOC, mg dm^{-3}	29.8 ±18.9	33.7 ±27.2	58.3 ±6.1	32.1 ±4.5	13.3 ±9.4	20.5 ±6.7

Poland, 50° 37.663′663 N, 23° 03.147′ E). The peat bog pools showed visible differences in the habitat conditions (environmental parameters) (Tab. 1).

The samples of bottom fauna (10 cores of the sediments per 1 sample) were taken in May, July and October 2012, (3 samples per peat bog pool per season), using a tube apparatus (surface area 15.2 cm^2). The sediments collected were sieved through the 250 μm mesh size, put into the plastic bags and transported to the laboratory. Next invertebrates were selected from samples and preserved in 4% formaldehyde solution, counted and identified. The nomenclature of taxa was accepted after Wiederholm [1983] and Kołodziejczyk and Koperski [2000]. Densities were calculated per m^2 of bottom surface.

Water samples for chemical analysis were taken in three replicates at the same sites and dates as chironomids. *In situ* were recorded pH, conductivity and dissolved oxygen by means of YSI 556 MPS electrode. Concentrations of $N\text{-}NO_3$, total phosphorous (TP) and $P\text{-}PO_4$ were determined at the laboratory, using spectrophotometric methods according Hermanowicz *et al*. [1999]. The concentration of chlorophyll *a* was analyzed by spectrophotometric method following a 24-h extraction with 90% acetone in the dark [Golterman 1969].

The influence of peat bog pool and season on the density of bottom fauna and its taxonomic richness were verified using two-way analysis of variance ANOVA. Test of Kruskal-Wallis was used to compare significant ($P < 0.05$) differences between means. Spearman rank correlation coefficients were calculated in order to recognize environmental variables responsible for distribution of zoobenthos between and within the types of peat bog pools. All the analysis was performed by means of Statistica 7.0 Software.

RESULTS AND DISCUSSION

In total, 28 taxa of bottom fauna were observed in studied peat bog pools. Number of taxa varied between 5 and 10 taxa and depended on the type of peat bog pool and season. Observed taxonomic diversity of bottom fauna is typical for shallow eutrophic lakes with sparse submerged vegetation [Brodersen *et al*. 2001, Bogut *et al*. 2007].

The density of benthic fauna ranged from 264 ind. m^{-2} (P1_RB October; P1_TB May; P2_F October) to 2244 ind. m^{-2} (P1_F July) and showed variability between studied peat bog pools and seasons, but observed differences were not significant (Fig. 1). In peat bog pools on raised bogs and fens the highest abundances of zoobenthos were noted in July (1320–2244 ind. m^{-2}) and the lowest in May or October (264–396 ind. m^{-2}). In transitional bog pools, the highest densities of bottom fauna were observed in October (1056–1188 ind. m^{-2}). Seasonal variations in abundances of zoobenthos are the result of differences in the length of life cycles of subsequent benthic species, e g. emergences of Chironomidae larvae usually take place in late spring and summer, at that time their densities in the sediments are the lowest [Armitage *et al*. 1995]. Often the highest abundances of zoobenthos are observed in autumn, due to the highest amounts of potential food resources (benthic algae, detritus) for most of benthic taxa [Maasri *et al*. 2008, Tarkowska-Kukuryk and Kornijów 2008].

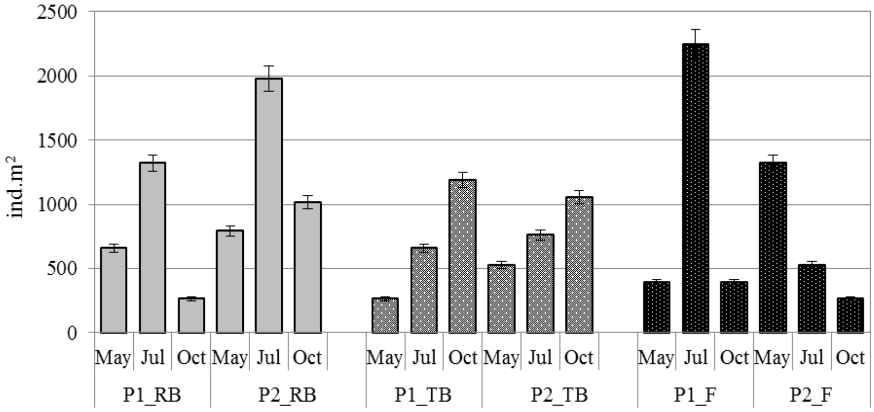

Fig. 1. Mean density (±SE) of zoobenthos in studied peat bog pools (May-October 2012)

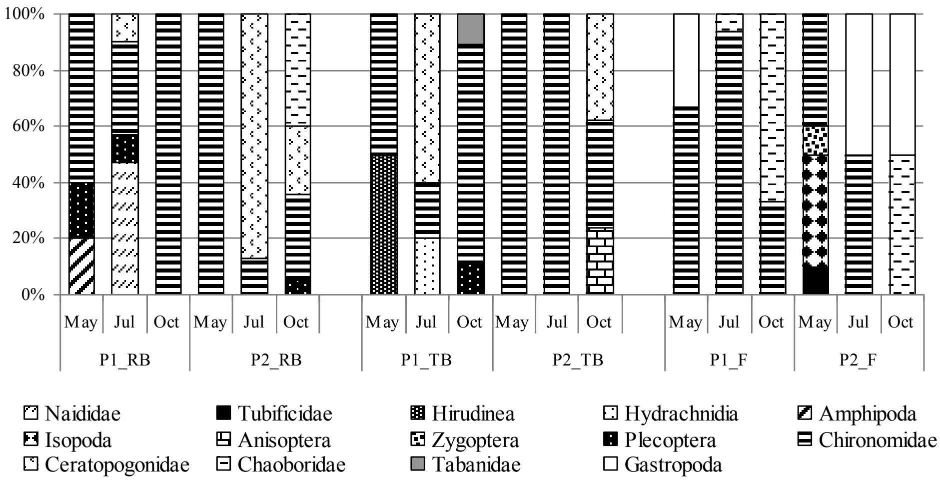

Fig. 2. Relative abundances of zoobenthos taxa in studied peat bog pools (May-October 2012)

Bottom fauna in all the pools studied was represented mainly by larvae of Chironomidae, which usually dominated the structure of zoobenthos assemblages in freshwater ecosystems [Real *et al*. 2000, Tarkowska-Kukuryk 2004]. The relative abundances of chironomids amounted from 13 up to 100% of total density of bottom fauna (Fig. 2) and varied between the type of peatbog pool and season. Moreover, in raised bogs pools high relative abundances obtained Naididae (47%) and Ceratopogonidae (10–87%), and in fen bog pools, Gastropoda (33–50%) and Chaoboridae (6–67%).

The concentrations of dissolved oxygen (r = 0.46; P = 0.048) and P-PO_4 (r = 0.51; P = 0.034) showed positive correlation with the density of bottom fauna and can be indicate as variables responsible for distribution of bottom fauna between peat bog pools. Usually oxygencontent and trophic conditions are stressed as the most important environmental factors affecting species structure and abundance of zoobenthos [Tolonen *et al*. 2001, Weatherhead and James 2001]. High zoobenthos diversity is usually observed in slightly eutrophic habitats, overgrown by macrophytes. The presence of vegetation provide high concentration of oxygen and after the end of vegetation period, become a source of organic matter for detritivorous benthic taxa.

The influence of trophic (food) conditions on domination structure and abundances of bottom fauna have been previously reported by van Duinen *et al*. [2006] who suggested that only in the most nutrient enriched raised bogs the quality of dead organic matter and/or abundance and quality of algae are sufficient to support the high diversity of invertebrate assemblages.

The results of the study have shown that both abundance and taxonomic richness of zoobenthos in peat bog pools on Roztocze National Park are not habitat specific. We observed seasonal differences in density and species richness between studied peat bog pools, but they were not significant. According to correlation coefficients, bottom fauna showed positive relation with concentrations of dissolved oxygen and P-PO_4, what may suggest the importance of trophic (food) conditions for the development of zoobenthos in peat bog pools. This observation indicate a similarity of peat bog pool habitats to littoral of shallow lakes with sparse submerged vegetation.

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ZOOBENTOS TORFIANEK ROZTOCZAŃSKIEGO PARKU NARODOWEGO: STRUKTURA, SEZONOWA ZMIENNOŚC, WPŁYW PARAMETRÓW SIEDLISKOWYCH

Streszczenie. Badania struktury taksonomicznej i zagęszczenia zoobentosu zasiedlającego torfianki na torfowiskach wysokich, przejściowych i niskich prowadzono na terenie Roztoczańskiego Parku Narodowego. Analizę struktury fauny dennej przeprowadzono pod kątem warunków siedliskowych (parametrów fizyczno-chemicznych). Ogólna liczba taksonów zoobentosu (od 5 do 10 taksonów zależnie od torfowiska) była niska, typowa dla płytkich jezior o kępowym porośnięciu dna przez makrofity. Zagęszczenie fauny dennej wykazywało wyraźną sezonową zmienność i wahało się od 264 do 2244 osobn. m^{-2}, jednak obserwowane różnice nie były istotne statystycznie. Niezależnie od typu torfowiska głównym komponentem zoobentosu były larwy Chironomidae, które stanowiły od 13 aż do 100% ogólnej liczebności fauny dennej.

Słowa kluczowe: fauna denna, makrobezkręgowce, torfianki, drobne zbiorniki wodne