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COMPARISON OF THE ROTIFERA AND CRUSTACEAN COMMUNITY STRUCTURE OF TWO POST-EXCAVATION PEAT PITS NEAR TUREW, WIELKOPOLSKA REGION, POLAND

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Summary. The study was made in order to compare the structure of the zooplankton community inhabiting various vegetation stands and the open water zone of two post-excavation peat pits. Even though these ponds were neighbouring, out of 80 zooplankton species only 45% were common for both ponds. The species richness as well as densities were the highest among macrophyte stands and the lowest within the zones of open water. Unvegetated zones were mainly dominated by limnetic species, while in vegetated areas both limnetic and littoral forms dominated. *Ceriodaphnia quadrangula* prevailed significantly in one of the ponds, while ten other species (e.g. *Lecane furcata*, *Mytilina mucronata*, *Alona rectangula*, *Chydorus sphaericus*, *Lathonura rectirostris*, *Pleuroxus laevis*) in the second pond, dominated by *Ceratophyllum* beds as well as by filamentous algae mats.

Key words: rotifers, crustaceans, peat pit, species diversity

INTRODUCTION

In small water bodies complex food webs consisting of micro-organisms, primary producers with phytoplankton and the periphytic community, macrophytes, zooplankton and benthic grazers, as well as vertebrate and invertebrate predators are characteristic. It is known that ponds often maintain a high level of biodiversity by creating favourable conditions for their inhabiting organisms [Hawksworth 1996]. Moreover, various macrophyte stands within a pond create differing habitat conditions that may have a great influence on the life conditions of the inhabiting organisms, including rotifers and crustaceans [Kuczyńska-Kippen *et al.* 2003, Kuczyńska-Kippen 2005]. It has already been stated by some authors that habitat structure is one of the fundamental factors determining the distribution of organisms at all spatial scales, and vegetation is of primary importance in shaping the structural environment for invertebrates in many systems [McAbendroth *et al.* 2005]. Therefore, even though a pond is of a small size and depth, it is essential to conduct research within different macrophyte habitats which vary in their structural architecture and complexity.

Peat bogs may be natural or anthropogenic types of water bodies, originated from the excavation of peat which has been used for energy production. These Man-made pools located within extensive wetlands are frequently fishless reservoirs. Extensive swamp or marsh areas occur usually adjacent to such water bodies. Such kinds of water bodies usually have only a narrow range of water chemistry (pH) and distinct vegetation assemblages growing above the accumulated peat.

Peat pits belong to ecological communities that are found in most climatic zones of the world. Peat originates from plant matter. The specific type of peat depends on the kind of plant matter and vascular plant material that forms peat, including leaf litter, plant branches and stems as well as dead roots. Fibrous plant debris is produced by the partial disintegration of plant material. Water from the peat water bodies may often take on a brown colouration.

To determine the influence of differentiated habitat on zooplankton abundance and species composition, planktonic components were sampled. The aim of this study was to compare the structure of rotifer and crustacean communities inhabiting various macrophyte stations and the open water zone of two neighbouring post-excavation peat pits.

STUDY AREA, MATERIALS AND METHODS

The distribution of zooplankton communities among different types of macrophytes (including rushes – *Typha angustifolia*, two zones of submerged macrophytes – *Ceratophyllum demersum* and *Chara hispida* and algae mat) as well as the open water between particular vegetation stands was studied on two post-excavation peat pits, located within a complex of meadows, near Turew (Wielkopolska region) in the summer of 2003. The ponds were surrounded by a narrow line of willow bushes with *Salix cinerea* dominating. Among the rush vegetation phytocoenosis of *Phragmitetum australis* and *Typhetum angustifoliae* prevailed. Elodeids and nymphaeids were represented by communities of *Charetum hispidae*, *Ceratophylletum demersi*, *Nupharo-Nymphaeetum albae*, *Hydrocharietetum morsus-ranae* and *Urticularia vulgaris*.

Samples were taken using a plexiglass core sampler (∅ 50 mm) [Schriver *et al.*, 1995]. Subsamples of a volume of about 1.5 L from the surface layer (0-1.0 m) were pooled together into a calibrated vessel. The collected material of a total volume of 5 L was concentrated using a 45-µm plankton net and was fixed immediately with 4% formalin.

Species diversity of rotifers inhabiting different habitats was examined using the Shannon-Weaver index [Margalef 1957]. The U-Mann test was used for statistical analysis in order to evaluate differences in the density of rotifers and crustaceans between particular habitats and water bodies (N = 18).

RESULTS

Out of 80 species (53 rotifera, 16 cladocera and 11 copepoda) identified in total, only 45% of the taxonomical structure was common for both examined water bodies. The species richness varied between the sampling stations with the lowest values within the zone of open water and the highest among macrophyte stands (Fig. 1), however, in the case of the second bog this was much higher with the most diverse structure found among the algae mat (59 species in total).

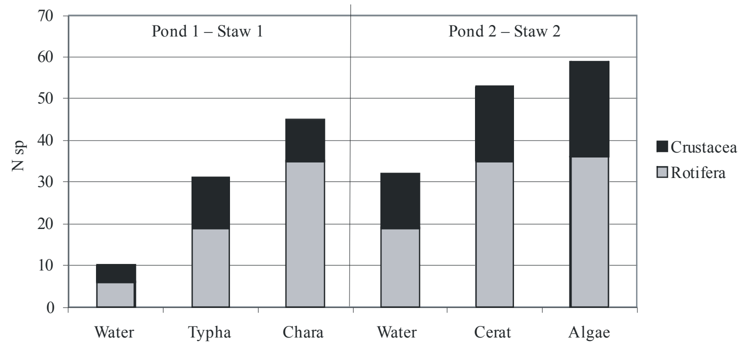

Fig. 1. Number of zooplankton of the examined water bodies (Water – open water zone; Typha – *Typha angustifolia*; Chara – *Chara hispida*; Cerat – *Ceratophyllum demersum*; Algae – algae mat)
Rys. 1. Liczba gatunków zooplanktonu badanych zbiorników wodnych (Water – otwarta toń wodna; Typha – *Typha angustifolia*; Chara – *Chara hispida*; Cerat – *Ceratophyllum demersum*; Algae – mata glonów nitkowatych)

Rotifera dominated taxonomically over Cladocera and Copepoda at all the sampling stations, however, on analysing their densities the dominance of crustaceans over rotifers was noticed in most cases (Fig. 2). Moreover, macrophyte zones were characterised by higher zooplankton abundance than open water areas. Comparing zooplankton densities it was found that the second pit possessed higher mean abundance that the first pond (Fig. 3).

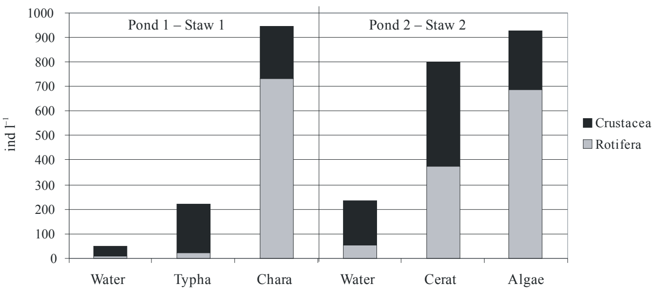

Fig. 2. Zooplankton densities of the examined water bodies (Water – open water zone; Typha – *Typha angustifolia*; Chara – *Chara hispida*; Cerat – *Ceratophyllum demersum*; Algae – algae mat)
Rys. 2. Liczebność ugrupowań zooplanktonu badanego zbiornika wodnego (Water – otwarta toń wodna; Typha – *Typha angustifolia*; Chara – *Chara hispida*; Cerat – *Ceratophyllum demersum*; Algae – mata glonów nitkowatych)

The dominance structure comprised a total of 19 zooplankton species, however, the first pond possessed 12, while the second one 15 species. There were seven common dominants for both water bodies, while 4 species dominated exclusively in pond No. 1 and 7 in pond No. 2 (Tab. 1). In the open water area only 3 and 4 dominating species were found, respectively. The vegetated stands were characterised by a more diverse dominating structure, up to 9 species among the algae mat in the second pit. *Colurella uncinata* (O.F. Müller) dominated in five and *Lecane luna* (O.F. Müller) in four out of six analysed sampling stations. The open water zones were dominated mainly by limnetic species, while within vegetated stands both limnetic and littoral species occurred.

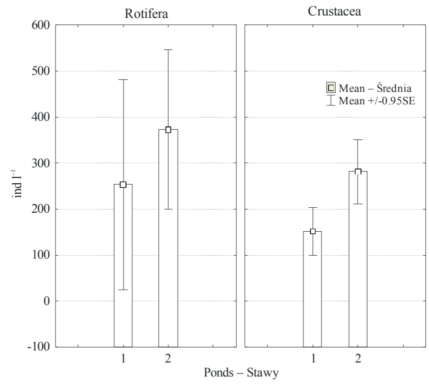

Fig. 3. Comparison of rotifers and crustaceans densities in both studied ponds
Rys. 3. Porównanie liczebności wrotków i skorupiaków w obu badanych stawach

The mean Shannon-Weaver biodiversity index values ranged from 1.15 to 2.55, with the lowest values within the open water zones of both examined reservoirs (1.15 and 1.54 respectively) and the highest among vegetated beds. In all cases rotifer communities were characterised by higher values of biodiversity index, however, within the algae mat crustaceans reached almost as high values as rotifers (Fig. 4).

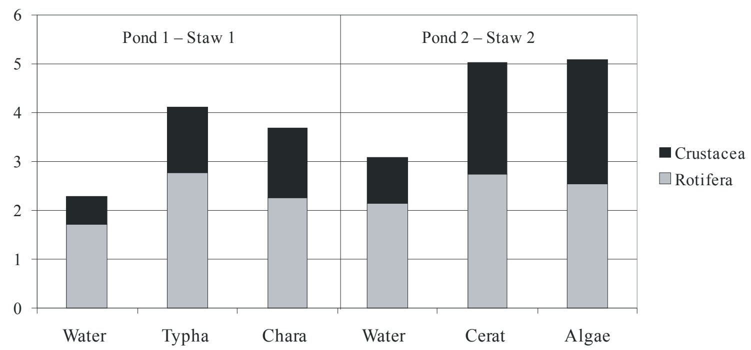

Fig. 4. Biodiversity index of zooplankton communities in both water bodies (Water – open water zone; Typha – *Typha angustifolia*; Chara – *Chara hispida*; Cerat – *Ceratophyllum demersum*; Algae – algae mat)
Rys. 4. Wskaźnik różnorodności gatunkowej ugrupowań zooplanktonu w badanych stawach (Water – otwarta toń wodna; Typha – *Typha angustifolia*; Chara – *Chara hispida*; Cerat – *Ceratophyllum demersum*; Algae – mata glonów nitkowatych)

Comparing both water bodies it was recorded that only in one case (*Ceriodaphnia quadrangula* (O.F. Müller) – $Z = -2.2076$, $p < 0.05$) were zooplankton densities statistically higher in pond No. 1, while ten species (*Keratella valga* (Ehrenberg) – $Z = 3.1789$, $p < 0.01$; *Lecane furcata* (Murray) – $Z = 2.4283$, $p < 0.05$; *Lecane ludwigi* (Eckstein) – $Z = 2.7815$, $p < 0.01$; *Mytilina mucronata* (O.F. Müller) – $Z = 2.5166$, $p < 0.05$; *M. ventralis* (Ehrenberg) – $Z = 2.7815$, $p < 0.01$; *Trichocerca lophoessa* (Gosse) – $Z = 2.3842$, $p < 0.05$; *Alona rectangula* Sars – $Z = 3.1789$, $p < 0.01$; *Chydorus sphaericus* (O.F. Müller) – $Z = 3.0906$, $p < 0.01$; *Lathonura rectirostris* (Müller) – $Z = 2.7815$, p 0.01; *Pleuroxus laevis* Sars – $Z = 2.7815$, $p < 0.01$) prevailed in pond No. 2.

Table 1. Dominating species of zooplankton in both examined water bodies
Tabela 1. Gatunki dominujące zooplanktonu w obu badanych stawach

Pond – Staw	1			2		
Station – Stanowisko	Water– Woda	Typha	Chara	Water – Woda	Cerat	Algae
Rotifera						
Bdelloidae		x				x
Colurella uncinata (O.F. Müller)	x	x	x		x	x
Keratella valga (Ehrenberg)				x		
Lecane closterocerca (Schmarda)		x				
Lecane luna (O.F. Müller)			x	x	x	x
Lepadella patella (O.F. Müller)		x				x
Mytilina mucronata (O.F. Müller)					x	
Mytylina ventralis (Ehrenberg)						x
Crustacea						
Ceriodaphnia quadrangula (O.F. Müller)		x				
Ceriodaphnia reticulata (Jurine)		x				
Chydorus sphaericus (O.F. Müller)					x	x
Daphnia longispina O.F. Müller	x	x		x		
Lathonura rectirostris (O.F. Müller)					x	x
Pleuroxus laevis Sars					x	
Simocephallus exspinosus (Koch)			x			x
Simocephallus vetulus (O.F. Müller)						x
Acanthocyclops vernalis (Fischer)			x			
Eudiaptomus gracilliodes (Lilljeborg)	x			x		
Harpacticoidae			x		x	

Analysing the habitat preferences between open water and macrophyte stands in both pits it was found that statistically higher densities of zooplankton among vegetation beds were found in the case of seven species (*Bdelloidae* – $Z = -2.5107$, $p < 0.05$; *Colurella uncinata* – $Z = -1.9596$, $p < 0.05$; *Lecane bulla* (Gosse)– $Z = -2.2045$, $p < 0.05$; *Lepadella patella* (O.F. Müller) – $Z = -2.9394$, $p < 0.01$; *Lophocharis* sp. – $Z = -1.8371$, $p < 0.05$; *Simocephalus exspinosus* (Koch) – $Z = -2.6332$, $p < 0.01$; *Harpacticoidae* – $Z = -2.1433$, $p < 0.05$).

DISCUSSION

Although both studied peat-pits are neighbouring, out of 80 zooplankton species identified in total, only 45% of them were common for both ponds. The species richness was found to be the highest among macrophyte stands and the lowest within the zones of open water. Numerous authors [e.g. Irvine *et al*. 1990, Vuille 1991] have stated that both rotifers and crustaceans, which evolutionarily prefer littoral habitats [Pejler 1995], build rich communities in vegetated areas. The macrophyte-dominated sites of both water bodies had higher zooplankton densities compared to the open water zones. The structural complexity of macrophytes is likely to provide a wide variety of potential refuges for zooplankton from predators and this is why a greater abundance of this group of animals was found in more heterogeneous habitats. Walsh [1995] noticed that increasing complexity of plant architecture supports organisms by offering better protection from predators.

The structure of dominating species often exerts an influence on such aspects as habitat selectivity, migrations as well as food availability. It was found that out of a total of 19 zooplankton dominants only seven species were common for both water bodies. The macrophyte areas had a more diverse dominating structure with 9 species among the algae mat in the second pit. Two rotifer species that are typically littoral-associated forms – *Colurella uncinata* and *Lecane luna* – dominated in most of the analysed sampling sites. Moreover, open water areas were mainly dominated by limnetic species, while macrophyte zones were dominated by both limnetic and littoral forms. The relatively high participation of limnetic species within stands of water vegetation is a result of their search for refuge among morphologically and spatially complicated habitats as well as of the interactions between macrophyte-associated zooplankton and organisms which stay temporarily or permanently in the water within the plant stand [Jeppesen *et al*. 1998].

Species richness may serve as an indicator of the distribution of species within an ecosystem and therefore examining the differentiated habitats of one water body becomes necessary due to the fact that higher species diversity is a reflection of good environmental conditions as well as a more complex and healthier community of organisms. The mean Shannon-Weaver biodiversity index values varied for both examined reservoirs between 1.15 and 2.55, with the lowest values characteristic for the most homogeneous zones – the open water.

A comparison of the density distribution of particular zooplankton species between both water bodies found that only *Ceriodaphnia quadrangula* prevailed in pond No. 1, while ten other species (e.g. *Lecane furcata*, *Mytilina mucronata*, *Alona rectangula*, *Chydorus sphaericus*, *Lathonura rectirostris*, *Pleuroxus laevis*) in pond No. 2, where great areas were covered by *Ceratophyllum* as well as by filamentous algae mats.

The distribution of aquatic organisms often depends on predation pressure as well as on optimal consumption conditions. The macrophyte-dominated areas, owing to their great heterogeneity connected with the complex conglomeration of aquatic plants, provides animals with potential anti-predator refuges [Schriver *et al*. 1995] whose effectiveness depends on the density and morphological build of particular plant species. However, the littoral zone can also provide its inhabiting organisms with a nutritional food base, which consists, apart from phytoplanktonic forms present in the interstem spaces, of periphyton with great amounts of detritus, bacteria and protozoans [Gons 1979]. The specific architecture of an aquatic plant may also affect the type of periphyton available which may then be preferred by different freshwater organisms [Dvorak and Best 1982]. Habitat selectivity has been proved for a multiplicity of organisms [James *et al*. 1998], including zooplankton species [Pennak 1966]. In the case of the examined pits there were no species that exclusively prevailed in the open water area, while seven species selected vegetated zones. All those zooplankton representatives of higher densities among macrophytes (*Bdelloidae, Colurella uncinata*, *Lecane bulla*, *Lepadella patella*, *Lophocharis* sp., *Simocephalus exspinosus*, *Harpacticoidae*) were typical littoral forms [Koste 1978, Radwan *et al*. 2004], finding their optimum of development among aquatic vegetation. Organisms prefer one habitat over another one for different reasons. The life conditions, including physical-chemical parameters as well as the available food in a particular habitat, are of great importance [Conde-Porcuna 2000]. However, the concealment effectiveness of a macrophyte which relates to more structurally complex plants plays an important role. In natural water bodies there is usually a combination of different kinds of predators and their success depends on the increase of plant complexity [Van de Meutter *et al.* 2005]. Hanazato and Yasuno [1989] suggested that a combination of invertebrate and vertebrate predators is able to modify the structure of zooplankton communities. Moreover, fish may directly have a direct impact on zooplankton habitat selectivity since they also select certain macrophyte species for shelter sites [Petr 2000].

CONCLUSION

Even though two the neighbouring water bodies were of the same origin they differed significantly in their macrophyte cover and their zooplankton community structure, relating to the species diversity, community dynamics and the dominating structure. Moreover, differences concerned also the two types of habitats – vegetated and unvegetated areas.

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PORÓWNANIE STRUKTURY UGRUPOWAŃ WROTKÓW I SKORUPIAKÓW DWÓCH POWYROBISKOWYCH TORFIANEK OKOLIC TURWI, WIELKOPOLSKA, POLSKA

Streszczenie. Badania prowadzono w celu porównania struktury ugrupowań zooplanktonu zasiedlającego zróżnicowane płaty makrofitów oraz toń wodną dwóch powyrobiskowych torfianek. Mimo że oba stawy sąsiadowały ze sobą, spośród 80 gatunków zooplanktonu zaledwie 45% stanowiło element wspólny dla obu stawów. Zróżnicowanie gatunkowe i liczebności zooplanktonu były wyższe w obrębie stanowisk roślinnych, a najniższe w toni wodnej. Toń wodna zdominowana była głównie przez gatunki limnetyczne, podczas gdy makrofity przez zarówno formy limnetyczne, jak i litoralowe. *Ceriodaphnia quadrangula* istotnie przeważała w jednym ze stawów, podczas gdy dziesięć innych gatunków (np. *Lecane furcata*, *Mytilina mucronata*, *Alona rectangula*, *Lathonura rectirostris*, *Pleuroxus laevis*) w drugim zbiorniku wodnym, zdominowanym przez płaty *Ceratophyllum* oraz maty glonów nitkowatych.

Słowa kluczowe: wrotki, skorupiaki, torfianka, różnorodność gatunkowa