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GASTROTRICH FAUNA OF ELODEIDS AND BOTTOM SEDIMENTS IN A EUTROPHIC LAKE

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Summary. Species diversity of gastrotrich communities on elodeids and in bottom sediments of a eutrophic lake were compared in this paper. Twenty three species of *Gastrotricha* (20 in bottom sediments and 15 on elodeids) belonging to one family *Chaetonotidae* Zelnika were found in studied habitats. Species diversity of both habitats was reflected in diversity indices equal to 2.67 and 2.54 for bottom sediment and elodeid fauna, respectively. Eudominants in the bottom sediments were three species: *Chaetonotus oculifer* Kisielewski, *Ch. similis* Zelnika and *Heterolepidoderma gracile* Remane. The group of eudominants among elodeid fauna consisted of four species: *Ch. macrochaetus* Zelnika, *H. macrops* Kisielewski, *H. ocellatum* Mečnikow and *Lepidodermella squamata* Dujardin. In both studied habitats the percentage share of gastrotrich eudominants exceeded 40%. The similarity of gastrotrich fauna on elodeids to that in bottom sediments was low and equalled 38%. The analysis of percentage shares of eudominant species in the fauna of bottom sediments and in epiphytic fauna in the studied eutrophic lake and earlier studies on fauna from both habitats in lakes of different trophic status allow to supplement autecological characteristics of *H. ocellatum* Mečnikow and to classify it in the group of species closely related to vegetation.

Key words: *Gastrotricha*, lake, bottom sediments, epiphytic fauna

INTRODUCTION

Studies on gastrotrich fauna in bottom sediments of freshwaters allowed many problems in the ecology of *Gastrotricha* to be explained. Species composition and domination structure were determined in many types of waters [Kisielewski 1981, 1986, Kisielewska 1982, Nesteruk 1986, 1996b, Szkutnik 1986]. Vertical distribution, density and biomass of *Gastrotricha* were also analysed [Nesteruk 1991, 1996a].

Apart from bottom sediments, gastrotrich fauna inhabits also the aquatic vegetation. Our knowledge of the ecology of this community is not satisfactory.

First data on the occurrence of *Gastrotricha* among aquatic vegetation were given by Kisielewski [1981] for the fauna of peat bogs. That author distinguished three groups of gastrotrich taxa associated with plant communities. Data on species composition and domination structure in epiphytic fauna of gastrotrichs in the littoral of a mesotrophic lake were presented in papers by Nesteruk [2000, 2004]. Her next paper [Nesteruk 2007a] gave the species composition of epiphytic gastrotrich fauna in the littoral of eutrophic and dystrophic lakes.

The aim of this paper was to compare *Gastrotricha* from bottom sediments with elodeid fauna in a strongly eutrophic lake and to analyse the factors affecting the development of epiphytic gastrotrich communities.

STUDY AREA, MATERIAL AND METHODS

The study was carried out in Lake Bikcze situated in the buffer zone of the Poleski National Park (photo 1). Lake Bikcze, with 3.3 m maximum depth and 85 ha surface area, is a strongly eutrophic reservoir [Radwan and Kornijów 1998, Radwan *et al*. 2003]. Water pH ranged from 8.0 (in spring) to 9.4 (in summer) whilst the dissolved oxygen concentration was found to vary from 9.0 mg/l (spring) to 13.4 mg/l (summer).

Phot. 1. Lake Bikcze (photo by T. Nesteruk)

The lake is silted in its southern part and the bottom in the eastern part is sandy. The lake is surrounded by a dense belt of *Scirpo-Phragmitetum* rushes. Southern and south-eastern parts of the belt are inhabited by the yellow water lily (*Nuphar luteum*), the hardy water lily (*Nymphaea candida*) and the floating-leaf pondweed (*Potamogeton natans*). Southern part of the lake is overgrown by clumps of bulrush (*Scirpus lacustris* L.). A common macrophyte in the littoral of the lake is the Canadian pondweed (*Elodea canadensis*) which forms a dense belt around the lake.

An abundant community with the water soldier *(Stratiotes aloides* L.) develops in the western part of the lake. There is a cluster of the common spike-rush (*Eleocharis palustris* (L.) Roem. et Schult.) on the sandy bottom at the eastern shore.

Samples from three sites in Lake Bikcze were collected four times in the vegetative season (April, June, August and October) in the years 2007 and 2008 because the fauna of *Gastrotricha* is most numerous from spring to autumn [Kisielewska 1982].

Aquatic plants were taken using a small anchor. The plants from which the fauna was collected included *Elodea canadensis, Nuphar luteum, Potamogeton natans* and *Stratiotes aloides*. The water was squeezed out from the plants into a container; the surface of yellow water lilies and water soldiers was scraped with a scalpel. Material collected in that way was mixed and used to determine species composition and percentage share of particular species in the total fauna of *Gastrotricha*. During the whole study period 24 samples were collected, in which all individuals of *Gastrotricha* were identified to species.

Samples from bottom sediments were taken with the use of a tubular bottom corer [Kajak *et al.* 1965] with cross-section surface area of 10.4 cm^2. The upper 10 cm sediment layer containing approximately 96.5% of all *Gastrotricha* [Nesteruk 1991] was examined. During the whole study period 24 samples were collected. All individuals were identified to species. The dominance (D) was expressed by the percentage of individuals of a given species in the total number of individuals of all species found. Coefficients of domination allowed to divide these species into five classes: (1) eudominants (> 10.0%), (2) dominants (5.01–10.0%), (3) subdominants (2.01–5.0%), (4) recedents (1.01–2.0%), (5) subrecedents (≤ 1.0%).

The Shannon-Wiener species diversity index (*H'*) was calculated according to the formula given in Shannon and Weaver [1963]:

$$H' = -\sum n_i/N \ln n_i/N$$

where:
n_i – number of individuals of the *i*-th species,
N – total number of all gastrotrichs.

Similarity of elodeid gastrotrichs to those living in bottom sediments was expressed with the homogeneity coefficient after Riedl [1963]:

$$HD = \sum_{i=1}^{s} (\sum_{j=1}^{k} \frac{D_{ij}}{k}) \frac{D_{\min_i}}{D_{\max_i}}$$

where:
D_{ij} – the domination index of the *i*-th species at the *j*-th site with a total of *s* species in *k* sites

RESULTS AND DISCUSSION

Twenty three species of *Gastrotricha* belonging to one family *Chaetonotidae* Zelnika were found in the studied littoral habitats of the eutrophic lake. Elodeid fauna was represented by 15 species and the fauna of bottom sediments by 20 species. The fauna of *Gastrotricha* from studied habitats differed in species composition and in the domination structure (Tab. 1).

Table 1. Species composition and percentage contribution of *Gastrotricha* in bottom fauna and elodeid fauna in studied lake (average values, n = 24)

Species	Bottom sediments	Elodeids
Aspidiophorus paradoxus (Voigt, 1902)	1.2	
A. squamulosus Roszczak, 1936	3.1	5.4
Chaetonotus rafalski Kisielewski, 1979	1.8	
Ch. brevispinosus Zelinka, 1889	1.8	
Ch. disiunctus Greuter, 1917	16.2	
Ch. oculifer Kisielewski, 1981	7.2	4.9
Ch polyspinosus Greuter, 1917	8.2	5.8
Ch. similis Zelinka, 1889	10.2	6.6
Ch. sphagnophilus Kisielewski, 1981	6.2	9.2
Ch. hystrix Mećnikow, 1865	3.2	7.2
Ch. macrochaetus Zelinka, 1889	1.3	11.6
Ch. persetosus Zelinka, 1889		1.6
Ch. acanthodes Stokes, 1887		2.1
Heterolepidoderma gracile Remane, 1927	15.4	1.0
H. macrops Kisielewski, 1981		10.8
H. majus Remane, 1927	4.5	4.4
H. ocellatum (Mečnikow, 1865)	2.0	12.8
Ichthydium forficula Remane, 1927	2.0	
I. podura (Müller, 1773)	2.5	
Lepidodermella minor (Remane, 1935)	2.4	5.4
L. squamata (Dujardin, 1841)	6.8	11.2
Polymerurus nodicaudus (Voigt, 1901)	2.2	
P. rhomboides (Stokes, 1887)	1.8	
Total	100.0	100.0

Eudominants in the bottom sediments were three species: *Chaetonotus oculifer* Kisielewski, *Ch. similis* Zelnika and *Heterolepidoderma gracile* Remane. The group of eudominants among elodeid fauna consisted of four species: *Ch. macrochaetus* Zelnika, *H. macrops* Kisielewski, *H. ocellatum* Mečnikow and *Lepidodermella squamata* Dujardin. In both studied habitats the percentage share of gastrotrich eudominants exceeded 40% (Fig. 1).

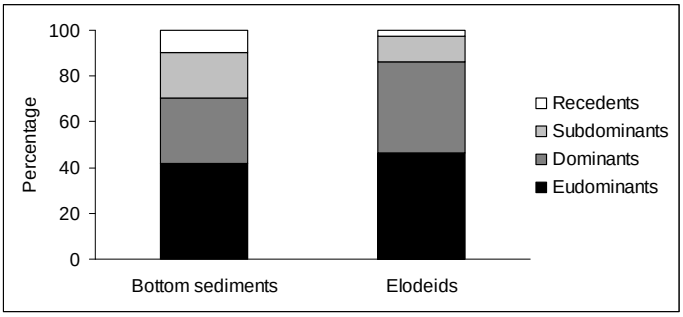

Fig. 1. Proportion (% of total numbers of individuals) of classes of dominance of epiphytic and bottom sediments gastrotrich fauna of littoral in studied lake (average values; n = 24)

There were 12 species common for both analysed habitats. Noteworthy, the percentage share of four of these species (*Ch. polyspinosus* Greuter, *Ch. similis*, *Ch. sphagnophilus* and *L. squamata*) exceeded 5%, classifying them to the group of dominants in both habitats. Species diversity of both habitats was reflected in the diversity indices equal to 2.67 ±0.12 and 2.54 ±0.13 for bottom sediment and elodeid fauna, respectively. Mean similarity of the fauna of bottom sediments to elodeid fauna was 38% (Tab. 2).

Table 2. The number of species, diversity index H' (average values ±SD, n = 24) and homogeneity index (HD) for bottom and epiphytic fauna of *Gastrotricha* in the littoral of studied lake

Parameters	Bottom sediments	Elodeids
Number of species	20	15
Diversity index (H')	2.67 ±0.12	2.54 ±0.13
Homogeneity index HD (%)	38	
Years of study	2007–2008	2007–2008

Epiphytic fauna of invertebrates in water bodies is composed of the same systematic groups as zoobenthos. However, the species composition, domination structure and seasonal dynamics differ markedly between the two communities [Kornijów *et al.* 1990]. Obviously different is also the role of both communities in the functioning of aquatic ecosystems, particularly in the context of recently

verified significance of herbivore invertebrates as important macrophyte consumers [Lodge 1991, Newman 1991, Kornijów 1994, 1996].

Studies on epiphytic and bottom fauna of Gastrotricha demonstrate that the species composition and domination structures of these communities differ markedly. From among four species dominating in the community of elodeid gastrotrichs in the studied lake, three (*Chaetonotus macrochaetus, Heterolepidoderma ocellatum* and *Lepidodermella squamata)* are eurytopic species.

Ch. macrochaetus is a species characteristic for the community *Heterolepidoderma ocellatum f. sphagnophilum*, and *H. ocellatum* – for the community *Ichthydium forficula.* The two mentioned communities are common in sphagnum bogs [Kisielewski 1981]. *Ch. macrochaetus* is a species with a broad ecological spectrum. It is present in peat-hags, ponds, in sphagnum bogs, alder woods, rush communities and in lakes of various trophic status.

H. ocellatum lives in peat-bogs, in lakes of various trophic states, in ponds and peat-hags. The species is more frequent among vegetation than in the mud. In the studied eutrophic lake domination of this species on elodeids is over 6 times higher than in bottom sediments. Studies carried out on a dystrophic lake [Nesteruk 2007a] indicated that the percentage share of *H. ocellatum* in the whole elodeid fauna was above 14% while in bottom sediments the species was not found.

L. squamata is a typical lake species. It is present in lakes of different trophic status, also in mountain and sea-shore lakes [Kisielewski and Kisielewska 1986, 1986a, Nesteruk 1996b]. The species can also be found in all types of substrata: in mud, among vegetation and in sand [Nesteruk 2007b]. The percentage share of the species in epiphytic fauna of the studied lake is approximately two times higher than in its bottom sediments and in a mesotrophic lake [Nesteruk 2004] it is 15 times higher.

H. macrops has long been known as a species associated with vegetation; its domination in epiphytic fauna of the studied lake exceeded 11%, and in its bottom sediments it was not found. Earlier researches by Nesteruk [2004] revealed that its domination in epiphytic fauna of a mesotrophic lake was ca. 28 times higher than in the bottom sediments of this lake.

In the bottom sediments of the studied eutrophic lake the eudominants were three species (*Ch. disiunctus, Ch. similis* and *H. gracile*). The first is a species common in peat-bogs, in bottom sediments of highly eutrophic water bodies and in bottom sediments of lakes of various trophic states. It lives mainly in mud, less frequently among decaying leaves and in sand. It does not occur among vegetation.

Ch. similis is present in water bodies of various trophic states. It was very often found in peat-hags, ponds, alder woods and in transitional peat-bogs [Kisielewski 1981, Kisielewska and Kisielewski 1986c, Nesteruk 1996b, 2007a] being present in all types of substrata (mud, plants, sand).

Worth noting is the species *H. gracile*, whose percentage share in the fauna of the bottom sediments of the studied lake exceeded 15% while in elodeid fauna

it was almost 15 times less frequent (1%). Earlier studies by Nesteruk [2004] showed that a similar share of this species was found in a mesotrophic lake (17% in bottom sediments and 1% among plants), while in a dystrophic lake it was not found on plants at all [Nesteruk 2007a]. A high percentage share of *H. gracile* was noted in the bottom sediments of extremely eutrophic and eutrophic water bodies of Białowieża Glade, in alder woods of Białowieża Forest [Kisielewska and Kisielewski 1986b, c], in lakes of the Poleski National Park and its buffer zone [Nesteruk 1996b, 2007a] and in ponds and peat-hags [Nesteruk 1996b].

Comparison of the values of diversity index (H') which includes the number of identified species and uniformity of their dominance shows lower diversity of lake plants than bottom sediments for *Gastrotricha*. It is important to emphasize that in both habitats the values of H' are high, distinctly below the values obtained for some alder carrs (H'= 2.95) [Kisielewska and Kisielewski 1986], basins with rushes vegetation (H'= 2.98) [Szkutnik 1986] and basins with the *Hydrocharitetum morsus-ranae* assembly (H'= 2.95) [Kisielewski 1986].

Domination structure of *Gastrotricha* in bottom sediments of lakes and on elodeids is an effect of many factors. One of them is wave action which may cause washing out of the animals and spreading particular species. The relationship between domination structure and undulation was confirmed for nematodes in periphyton [Pieczyńska 1964]. Some authors indicate a possibility of migration in representatives of both habitats [Hanson 1990]. This thesis seems true; one should, however, account for the fact that particular species prefer a definite type of substratum (sandy, muddy, stony) where they find optimum life conditions [Dusoge 1966, Kajak 1988, Kornijów 1989]. The latter is evidenced by differences in the species composition between the two Gastrotrich communities at a similar number of species in both. It seems that the exchange of representatives of both habitats may concern only a few eurytopic species but the typical representatives of bottom fauna (*Ch. disiunctus, Ch. heteracanthus, I. palustre*, and species of the genus *Polymerurus* Remane) were never found on aquatic vegetation. The two habitats showed a low similarity of fauna. The similarity of bottom sediments fauna to that from elodeids in the studied eutrophic lake measured with the Riedl [1963] homogeneity index was only 38%. Kornijów [1992] described, on the example of *Chironomidae*, the migration of epiphytic fauna to bottom sediments and back in spring, connected with autumn macrophytes dying off. We may presume that this type of migration is also seen in gastrotrich fauna.

Recent studies on *Gastrotricha* carried out in different environments and habitats allowed to distinguish three groups of species different in the range of ecological tolerance: species closely related to aquatic vegetation, species closely related to bottom sediments, and species tolerating a broad range of environmental factors [Nesteruk 2007a]. The analysis of percentage shares of eudominant species in the whole fauna of bottom sediments and in epiphytic fauna in the studied eutrophic lake and earlier studies on fauna from both habitats in

lakes of different trophic status [Nesteruk 2000, 2004, 2007a] allows to supplement the autecological characteristics of *H. ocellatum* and to classify it to the group of species closely related to vegetation.

CONCLUSIONS

1. Species diversity of *Gastrotricha* in bottom sediments of the studied lake is higher than that of *Gastrotricha* on elodeids.

2. In bottom sediments of the studied eutrophic lake the eudominants were three eurytopic species of *Gastrotricha*. From among four species dominating in the community of elodeids three are eurytopic species, too.

3. Gastrotrich fauna on elodeids in the studied eutrophic lake shows a low similarity (measured with the homogeneity index) to the fauna of bottom sediments.

4. High percentage share of *Heterolepidoderma ocellatum* Mečnikow in the epiphytic fauna of the studied lake and earlier studies in lakes of different trophic status allow to classify it to the group of species closely related to vegetation.

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BRZUCHORZĘSKI ELODEIDÓW I OSADÓW DENNYCH W JEZIORZE EUTROFICZNYM

Streszczenie. W prezentowanej pracy porównano zróżnicowanie gatunkowe zgrupowań brzuchorzęsków elodeidów i osadów dennych w jeziorze eutroficznym. W obydwu siedliskach stwierdzono 23 gatunki brzuchorzęsków (20 w osadach dennych i 15 na elodeidach) należących do jednej rodziny *Chaetonotidae* Zelnika. Eudominantami w osadach dennych jeziora były trzy gatunki: *Chaetonotus oculifer* Kisielewski, *Ch. similis* Zelnika i *Heterolepidoderma gracile* Remane. Grupę

eudominantów fauny elodeidów stanowią cztery gatunki: *Ch. macrochaetus* Zelnika, *H. macrops* Kisielewski, *H. ocellatum* Mečnikow i *Lepidodermella squamata* Dujardin. W obu badanych siedliskach udział procentowy brzuchorzęsków klasy eudominantów przekroczył 40%. Różnorodność gatunkowa obydwu siedlisk znalazła odzwierciedlenie w wartościach jej wskaźnika, który dla fauny osadów dennych wynosi 2,67, a dla fauny elodeidów 2,54. Podobieństwo fauny brzuchorzęsków elodeidów do fauny osadów dennych w badanym jeziorze jest niskie i wynosi 38%. Analiza udziału procentowego gatunków brzuchorzęsków w całości fauny osadów dennych i fauny epifitycznej w badanym jeziorze eutroficznym oraz wcześniejsze badania tych dwóch siedlisk w jeziorach o różnej trofii pozwalają uzupełnić charakterystykę autekologiczną gatunku *H. ocellatum* Mečnikow i zakwalifikować go do grupy gatunków o silnym związku z roślinnością.

Słowa kluczowe: brzuchorzęski, jezioro, osady denne, fauna epifityczna