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SPECIES COMPOSITION AND DENSITY OF GASTROTRICHA OCCURRING ON TWO SPECIES OF MACROPHYTES IN A MESOTROPHIC LAKE

Teresa Nesteruk

Siedlce University of Natural Sciences and Humanities, Faculty of Natural Science, Department of Zoology, B. Prusa str. 12, 08-110 Siedlce, e-mail: teresa.nesteruk@uph.edu.pl

Abstract. The research was carried out on species diversity, density and similarity of Gastrotricha living on two species of macrophytes *Myriophyllum spicatum* L. and *Elodea canadensis* Michx. in a mesotrophic lake. Gastrotricha occurring on the studied macrophytes were represented by 23 species (21 on *M. spicatum* L. and 22 on *E. canadensis* Michx.). Species diversity (expressed by the Shannon index) for the Gastrotricha occurring on the two studied species of macrophytes amounted to 2.70 for *M. spicatum* L. and 2.81 for *E. canadensis* Michx., what suggests equal distribution of the gastrotrich species revealed in the studied species of macrophytes. The definite dominants inhabiting the two species of macrophytes were: *Heterolepidoderma macrops* Kisielewski, 1981, *Heterolepidoderma ocellatum* (Mečnikow, 1865), *Lepidoderma squamata* (Dujardin, 1841) and *Aspidiophorus squamulosus* Roszczak, 1936, and their inclusive percentage participation in the whole gastrotrich fauna for *M. spicatum* L. and *E. canadensis* Michx. was 41.8 and 40.3% respectively. The domination structure of the gastrotrich fauna of the two species of macrophytes was similar for each gastrotrich species (G-test, for all $p > 0.05$).

Average density of Gastrotricha inhabiting *M. spicatum* L. amounted to 588.0 10^3 indiv. m^{-2}, and density of Gastrotricha occurring on *E. canadensis* Michx. amounted to 670.0 10^3 indiv. m^{-2}. Statistic analysis based on the Mann-Whitney test showed that differences of the gastrotrich density on the studied species of macrophytes: *M. spicatum* L. and *E. canadensis* Michx. ($Z = -1.9282$; $p = 0.05$) are statistically insignificant.

Key words: *Gastrotricha*, epiphytic fauna, species composition, dominance, density

INTRODUCTION

Gastrotricha belong to the smallest invertebrates and they occur numerously in water ecosystems, not only in bottom sediments but also on submerged macrophytes. They feed on detritus, bacteria and algae. The majority of species occur in moderately acid environment. Some of them not tolerate acidity (pH = 4.0) [Nesteruk 1996b, 2005]. The majority of freshwater Gastrotricha is not much

sensitive to oxygen deficit what indicates the fact of occurrence of these animals in deeper layers of the organic slime up to 17 cm in depth counting from the surface [Nesteruk 1991].

Studies carried in an eutrophic Lake Yaonude Municipal in Kamerun (central Africa) showed that Gastrotricha belonging to gender Polymerurus Remane were especially numerous in almost oxygen deprived bottom sediments [Zebaze Togouet *at al*. 2007].

Last studies showed that in various types of standing water Gastrotricha and small invertebrates are more numerous on aquatic vegetation than in organic bottom sediments of these reservoirs [Nesteruk 2016]. So the question arises, if the type of vegetation has got an impact on density of Gastrotricha. The aim of this study is the comparison of number and diversity of Gastrotricha occurring on two species of macrophytes: *Myriophyllum spicatum* L. and *Elodea canadensis* Michx.

STUDY AREA, MATERIAL AND METHODS

The studies were carried out in mesotrophic Lake Piaseczno [Harasimiuk *et al*. 1998], situated about 170 km south-east of Warsaw, Poland in the region of Polesie Lubelskie., The area of Lake Piaseczno covers 83.8 ha and its maximum depth reaches up to 38.8 m. The northern part of the lake is narrow and deep, the southern part is wide and shallow. The lake is surrounded by a sandy beach of 20–30 m in width, and only its southern shallow part borders the transitional moor.

The bottom of the lake, especially in the northern and northwestern parts, is densely overgrown by *Charales*, while *Elodea canadensis* Michx., *Ceratophyllum demersum* L., and *Myriophyllum spicatum* L. occur in the water column. Water pH was 7.10, and 8.30 mg cm^{-3} of dissolved oxygen was found [Płaska 2009].

Samples from two sites in littoral of the lake were collected four times during the two consecutive vegetative seasons (April, June, August and October) in the years 2014 and 2015.

The study area comprised the littoral zone of the lake with its depth from 0.5 to 1.2 m. During the whole study period 16 samples were collected, in which aquatic vegetation constituted *Myriophyllum spicatum* L., and 16 samples in which aquatic vegetation constituted *Elodea canadensis* Michx. In the collected samples were identified 1697 individuals of Gastrotricha. All individuals were identified to species.

A square metal frame with half meter-long sides was placed at the bottom of the reservoir. All the plants were thus collected from an area restricted to 0.25 m^2 and put with water into a 10 l container. Five containers were then taken from that (each of 200 cm^3 volume) and used of particular taxa in the total fauna of Gastrotricha. The density was investigated in each container. A mixed portion of 2 cm^3 was taken from each container. The number of specimens in 2 cm^3 was

calculated in the whole volume (200 cm^3) of each of the five containers, and then in the whole volume of the collected sample. With the known surface area of a square metal frame (0.25 m^2) and the number of individuals in the whole volume of the collected sample, the number of individuals per m^2 of bottom area could be calculated [Nesteruk 2016].

Species dominance was calculated as

$$D = 100n / N$$

where: n – number of specimens of a given species, and N – total number of specimens.

Shannon-Wiener index of general diversity (H') was determined acc to Shannon and Weaver [1963]:

$$H' = - \sum p_i \ln p_i$$

where: $p_i = n_i / n$, n_i – number of i-species, n – total density of individuals in the zoocenosis.

Similarity of the gastrotrich fauna occurring on two species of macrophytes was assessed from the index of homogeneity [Riedl 1963]:

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

where: D_{ij} is the dominance index of the ith species at the jth stand with a total of s species an k stands.

Prior to statistical analysis, the distributions of variables were checked using the Shapiro-Wilk test. Since the distributions were not normal, nonparametric tests were used. The Mann-Whitney test was used to compare density of fauna of Gastrotricha occurring on two species of macrophytes in mesotrophic lake, and the G-test was used to compare the dominance structure of Gastrotricha fauna between two species of macrophytes. Analyses were performed by means of the program Statistica v. 12.0

RESULTS AND DISCUSSION

The study was conducted on species diversity, density and similarity of gastrotrich fauna occurring on two species of macrophytes: *Myriophyllum spicatum* L. and *Elodea canadensis* Michx. in a mesotrophic lake. Gastrotricha were abundant on the two studied macrophytes, there were recorded 23 species

of Gastrotricha belonging to the family of *Chaetonotidae.* Epiphytic fauna occurring on *M. spicatum* L. was represented by 21 species, and fauna occurring on *E. canadensis* Michx. by 22 species.

Average density of Gastrotricha inhabiting *M. spicatum* L. amounted to 588.0 10^3 indiv. m^{-2} and density of Gastrotricha occurring on *E. canadensis* Michx. amounted to 670.0 10^3 indiv. m^{-2} (Table 1). Statistic analysis made on the basis of the Mann-Whitney test showed that differences in the gastrotrich density on the studied macrophytes: *M. spicatum* L. and *E. canadensis* Michx. (Z= -1.9282; p = 0.05) are statistically insignificant.

Table 1. Species composition, density and percentage participation of particular species of Gastrotricha in their total abundance occurring on two species of macrophytes

Species	*Myriophyllum spicatum* L.			*Elodea canadensis* Michx.		
	A	*N*	*D*	*A*	*N*	*D*
Chaetonotus acanthodes Stokes, 1887	25.9	34	4.4	16.1	22	2.4
Ch. disiunctus Greuter, 1917	15.2	20	2.6	23.5	32	3.5
Ch. heideri Brehm, 1917	24.1	32	4.1	16.1	22	2.4
Ch. hystrix Mečnikow, 1865	27.0	36	4.6	29.5	40	4.4
Ch. insigniformis Greuter, 1917				6.0	8	0.9
Ch. macrochaetus Zelinka, 1889	31.8	42	5.4	39.5	54	5.9
Ch. persetosus Zelinka, 1889	11.8	16	2.0	22.1	30	3.3
Ch. spinulosus Stokes, 1887	11.8	16	2.0	8.7	12	1.3
Ch maximus Ehrenberg, 1830	25.9	34	4.4	34.8	48	5.2
Ch. oculifer Kisielewski, 1981	19.4	26	3.3	8.7	12	1.3
Ch. ophiogaster Remane, 1927				2.7	4	0.4
Ch. polyspinosus Greuter, 1917	32.2	43	5.5	45.6	62	6.8
Ch. poznaniensis Kisielewski 1981	4.7	6	0.8			
Ch. similis Zelnika, 1889	30.0	40	5.1	47.6	65	7.1
Ch. sphagnophilus Kisielewski,1981	15.9	21	2.7	23.4	32	3.5
Heterolepidoderma gracile Remane, 1927	25.9	34	4.4	32.8	45	4.9
H. macrops Kisielewski, 1981	72.3	96	12.3	84.4	115	12.6
Heterolepidoderma ocellatum (Mečnikow, 1865)	81.1	108	13.8	93.8	129	14.0
Lepidodermella squamata (Dujardin, 1841)	60.0	80	10.2	44.2	60	6.6
Aspidiophorus oculifer Kisielewski, 1981	15.3	20	2.6	25.5	35	3.8
A. squamulosus Roszczak, 1936	32.3	43	5.5	47.6	65	7.1
Ichthydium forficula Remane, 1927	11.8	16	2.0	7.4	10	1.1
I. podura (Müller, 1773)	13.5	18	2.3	10.0	14	1.5
Total	588.0	781	100.0	670.0	916	100.0

A – density (thousands indiv. m^{-2}), *D* – percentage contribution (%), N – the number of individuals of a given species

Species diversity (expressed by the Shannon index) for Gastrotricha occurring on the two studied species of macrophytes amounted to 2.70 for *M. spicatum* L. and 2.81 for *E. canadensis* Michx. The definite dominants inhabiting both species of macrophytes were: *Heterolepidoderma macrops* Kisielewski, 1981, *Heterolepidoderma ocellatum* (Mečnikow, 1865), *Lepidoderma squamata* (Dujardin 1841) and *Aspidiophorus squamulosus* Roszczak, 1936, and their inclusive percentage participation in the whole gastrotrich fauna for *M. spicatum* L. and *E. canadensis* Michx. was 41.8 and 40.3% respectively. The domination

structure of the gastrotrich fauna of the two species of macrophytes was similar for each gastrotrich species (G-test, for all $p > 0.05$).

Similarity of the gastrotrich fauna occurring on the both studied species of macrophytes measured by the homogeneity index is high and stands at 79.4% (Table 2).

Table 2. The number of species, diversity index *H'*, density and homogeneity index (*HD*) of Gastrotricha occurring on two species of macrophytes in a mesotrophic lake

Parameters	*Myriophyllum spicatum* L.	*Elodea canadensis* Michx.
Number of species	21	22
Diversity index (*H'*)	2.70	2.81
Density thousand indiv. m^{-2}	588.0	670.0
Homogeneity index *HD*, %	79.4	

Epiphytic fauna consists of the same systematic groups as bottom fauna but the species composition and dominance structure of both assemblages differ from each other [Kornijów 1989a, 1989b]. This applies to the studied gastrotrich fauna [Nesteruk 2011]. High percentage contribution of two species *H. ocellatum* and *H. macrops* in the entirety of gastrotrich fauna recorded on the two studied species of macrophytes allows to attribute them to the group of species closely related to vegetation.

Density of Gastrortricha in bottom sediments of lakes with different trophy grows together with the growth of trophy of a lake [Nesteruk 1996a]. The majority of groups of meiofauna shows, depending on the trophy and other features of a reservoir, differences in density up to few orders of magnitude [Strayer 1985]. It may be supposed that higher trophy of a reservoir finds reflection in a higher numerical amount and biomass of fauna. Analysis of the value of biomass of Gastrotricha with reference to the bottom surface of elodeid fauna showed that in an eutrophic lake it is 2 times higher than in a mesotrophic lake [Nesteruk 2009, 2010]. Biomass values are usually proportional to density of fauna in a lake.

Dependence of density and biomass on trophy of a reservoir was also recorded for macrofauna of elodeids in a mesotrophic and eutrophic lake [Kornijów 1989a]. In turn, in studies conducted in the lake Sakadaš (Croatia) it was demonstrated that invertebrates associated with macrophytes (*M. spicatum* L.) are consistent with trophy of the studied lake [Cerba *et al*. 2009].

High density of Gastrotricha on elodeids may be the result of good nourishment basis among the vegetation. Aquatic vegetation constitute nourishment basis for the majority of epiphytic fauna. Tissues of plants contain bacteria which are the

ingredients of a diet of the majority of Gastrotricha. The plentitude of bacteria, root excrections and decaying plant tissue make good nourishment conditions.

Some species of meioinvertebrates prefer algae to bacteria. The important component of water biocenoses are epiphytic algae. Kazemi-Dinan *et al*. [2014] found positive correlation between the density of peryphytic Nematoda and algae content, which shows that potential food availability may is conductive to the abundance of Nematoda. Biomass of epiphytic algae occurring on macrophytes changes during the year, it is distinctly higher in spring and autumn than in summer [Toporowska *et al*. 2008].

Researches carried out in an oligotrophic Lake Pääjärvi (southern Finland) revealed, that both the total density and biomass of all communities (zoobenthos, epiphytic fauna and nekton) were positively related to the biomass of *E. canadensis* Michx. Moreover, the density and biomass of elodeid fauna are equal and even higher than that of the fauna of bottom sediments [Kornijów and Kairesalo 1994]. The analysis of gastrotrich density living on elodeids in different types of freshwater reservoirs shows that they are more numerous on aquatic vegetation than in bottom sediments of these reservoirs [Nesteruk 2016].

CONCLUSIONS

1. Density of the gastrotrich fauna occurring on two macrophytes species is high, and differences are not statistically significant.

2. Similarity of the fauna of Gastrotricha occurring on the two species of macrophytes is high, which shows that the character of vegetation is not the main factor influencing the density and diversity of Gastrotricha.

3. The development of the gastrotrich community on macrophytes is mainly affected by trophic status of reservoirs and not by the character of vegetation.

4. Analysis of the percentage participation of the species of Gastrotricha in the whole fauna abundant on the studied macrophytes and the results of the previous researches allow to complete autecological characteristics of the two species: *H. ocellatum* Mečnikow and *H. macrops* Kisielewski, 1981 and qualify them to the group of species strongly related to vegetation.

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SKŁAD GATUNKOWY I ZAGĘSZCZENIE FAUNY BRZUCHORZĘSKÓW WYSTĘPUJĄCYCH NA DWÓCH GATUNKACH MAKROFITÓW W JEZIORZE MEZOTROFICZNYM

Streszczenie. Badano różnorodność gatunkową, zagęszczenie i podobieństwo fauny Gastrotricha żyjącej na dwóch gatunkach makrofitów, *Myriophyllum spicatum* L. i *Elodea canadensis* Michx., w jeziorze mezotroficznym. Brzuchorzęski występujące na badanych makrofitach reprezentowane były przez 23 gatunki. Różnorodność gatunkowa wyrażona wskaźnikiem Shannona dla fauny Gastrotricha występującej na obu badanych gatunkach makrofitów wynosiła: 2,70 dla *M. spicatum* L. i 2,81 dla *E. canadensis* Michx. Zdecydowanymi dominantami zasiedlającymi oba gatunki makro-

fitów są: *Heterolepidoderma macrops* Kisielewski, 1981, *Heterolepidoderma ocellatum* (Mečnikow, 1865), *Lepidoderma squamata* (Dujardin 1841) i *Aspidiophorus squamulosus* Roszczak, 1936, a ich łączny udział procentowy w całości fauny Gastrotricha wynosił dla *M. spicatum* L. i dla *E. canadensis* Michx. odpowiednio 41,8 i 40,3 %. Średnie zagęszczenie brzuchrzęsków zasiedlających *M. spicatum* L. wynosiło 588,0 10^3 indiv. m^{-2}, a zagęszczenie brzuchorzęsków zasiedlających *E. canadensis* Michx. wynosiło 670,0 10^3 indiv. m^{-2}. Podobieństwo fauny występującej na obu badanych gatunkach makrofitów mierzone współczynnikiem homogeniczności jest bardzo wysokie i wynosi 79,4%.

Słowa kluczowe: brzuchorzęski, fauna epifityczna, skład gatunkowy, dominacja, zagęszczenie