

LAKE ZONALITY INFLUENCE ON SPECIES DIVERSITY  
FORMATION OF *GASTROTRICHA*

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Abstract. The research was carried out in 1994-2000 from spring till autumn, in a mesotrophic Lake Piaseczno situated in the Łęczyńsko-Włodawskie Lakeland. The Shannon-Wiener species diversity index  $H'$  was determined for the studied lake zones, and fauna similarity was calculated on the basis of the homogeneity index [15]. In the lake, 37 species of *Gastrotricha* were found. In bottom sediments of littoral with sublittoral 22 species were abundant, and on submerged vegetation 20 species. In the psammon zone of the lake 11 species were found. The lowest value of  $H'$  was obtained for bottom sediments in the profundal zone of the lake (1.49). The most separate *Gastrotricha* fauna is abundant in bottom sediments of lake profundal, for which similarity with the rest of the lake zones amounts to 9.9-27.3%. In the lake eudominants ( $D > 10\%$ ) there were 10 species of *Gastrotricha*. Total dominance of eudominants in individual lake zones varied from 34.1% (shore) to 82.1% in lake profundal. The research carried out allows the completion of the autecological characteristics of the following species: *Ch. macrochaetus* and *Ch. disiunctus* which were previously found mainly on peat bogs and which appeared to be common eurytopic species. But *Ch. similis* and *L. squamata* are mainly lacustrine species.

Key words: *Gastrotricha*, species composition, dominance

INTRODUCTION

*Gastrotricha* constitute a constant element of inland water ecosystems. They are the most numerous in organogenic bottom sediments of inland water basins and on submerged vegetation. The majority of the species is little sensitive to oxygen deficiency. The abundance of living individuals in organogenic bottom sediments was ascertained up to the depth of 17 cm [9]. The prevailing number of species occupy moderately acid environments. Some of them tolerate acidification ( $pH = 4$ ), and others can occur in alkaline waters with the value of  $pH = 10$  [5,16].

One of the fundamental environments of freshwater *Gastrotricha* are ponds and lakes with different fertility. In organogenic bottom sediments of these basins live a fauna rich in species of *Gastrotricha* and its population amounts from 100 thousand to 2.6 million of individuals  $m^{-2}$  [10]. Lakes with developed zonality provide great habitat diversity which is very attractive for *Gastrotricha*. Species composition and dominance of gastrotrich fauna in individual zones of a mesotrophic lake is the subject of the present paper.

#### MATERIAL AND METHODS

The research was carried out in Lake Piaseczno (51° 23'N, 23° 02'E), located in the Łęczyńsko-Włodawskie Lakeland. Lake Piaseczno, of 38.8 m average depth and 83.8 ha surface area, is a mesotrophic reservoir without outflow. The lake is surrounded by a sandy beach, only the southern part borders on a peat bog of transitional type. Reaction of the lake waters is from quite acid to gently alkaline. Bottom sediments are rich in organic matter. Its content in the littoral amounts to 52.69% and in the profundal to 59.33% [11].

The research was carried out in 1994-2000. Samples were collected from April till October, because fauna of *Gastrotricha* is most abundant from spring till autumn [2]. Samples were collected in lake psammon zone, from bottom sediments along the shore of the peat bog, in the littoral with sublittoral, in the profundal, and from submerged vegetation in the littoral zone.

Samples from bottom sediments were taken using a tubular bottom sampler [1] with the cross-section surface of 10.4  $cm^2$ . Samples of epiphytic fauna were collected by means of a little anchor. Vegetation from which the fauna was collected consisted of *Myriophyllum sp.*, *Ceratophyllum sp.*, and *Elodea canadensis Michx.* [12]. Psammon samples were collected from the zone flooded by water using a metal barrel with sharpened bottom edges. The barrel, of 100 mm in diameter and 250 mm high, was provided with a pusher ended by a piston. From bottom sediments of the shore and in the lake profundal, 10 samples were collected from each zone; from the littoral with sublittoral – 20 samples. 20 samples were collected from the lake psammon and 20 from submerged vegetation of the littoral zone of the lake. In the material collected from all the zones of the lake, 2 744 specimens were found, which were all identified as belonging to specific species.

Species dominance was calculated as  $D = 100 \cdot n/N$ , where  $n$  – number of specimens of a given species, and  $N$  – total number of specimens. The following classes of dominance were accepted [5]: eudominants (>10%), dominants (5.01-10%), subdominants (2.01-5%), recedents (1.01-2%) and subrecedents ( $\leq 1\%$ ).

Species diversity in the studied lake zones was assessed from values of the Shannon-Wiener diversity index [17].

$$H' = -\sum p_i \ln p_i \quad (1)$$

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 in different lake zones was assessed as an index of homogeneity [15].

$$HD = \sum_{i=1}^s \left( \sum_{j=1}^k \frac{D_{ij}}{k} \right) \frac{D_{\min_i}}{D_{\max_i}} \quad (2)$$

where:  $D_{ij}$  is the dominance index of the  $i$ th species at the  $j$ th site with a total of  $s$  species of  $k$  sites.

## RESULTS

In the studied lake, a total of 37 species of *Gastrotricha* were recorded. The number of species in individual zones varied from 10 in the profundal to 25 on the shore. In bottom sediments of the littoral with sublittoral 22 species were found, and on submerged vegetation there were 11 gastrotrich species.

The highest value of the species diversity index  $H'$  was recorded for the lake shore (2.88) and for the littoral with sublittoral zone (2.56), the lowest value of the index was recorded for the lake profundal (Tab. 1).

In individual zones of the lake differences were recorded in the dominance of individual species (Tab.1). The number of eudominants in the lake amounts to 10, from which in individual zones there were 2 and 3. The whole dominance of eudominants in individual zones of the lake varies from 34.1% (shore) to 82.1% in bottom sediments of the profundal.

Similarity of gastrotrich fauna in individual zones of the lake, calculated on the basis of the index of homogeneity [15], is low and amounts from 9.9% for fauna of the profundal zone with fauna of the lake shore to 36.0% for fauna of the lake psammon with epiphytic fauna (Tab. 2).

**Table 1.** Species composition and individual dominance (%) of *Gastrotricha* in the zones of the lake. N – total number of specimens. P– psammon, S – shore, L/S – littoral/sublittoral, PL – plants, PR – profundal

Species	P	S	L/S	PL	PR
	N = 494	N = 272	N = 730	N = 1000	N = 112
<i>Chaetonotus</i> sp.			0.4	1.6	1.8
- <i>acanthocephalus</i> Valkanov, 1937		1.2			
- <i>acanthodes</i> Stokes, 1887			1.4		0.9
- <i>brevisetosus</i> Roszczak, 1935		4.4		0.4	
- <i>brevispinosus</i> Zelinka, 1989				0.8	
- <i>disiunctus</i> Greuter, 1917	8.3	2.2	5.3		11.6
- <i>heideri</i> Brehm, 1917	4.9	5.8	3.4	7.0	
- <i>heteracanthus</i> Remane, 1927		0.8	13.3		0.9
- <i>hystrix</i> Mečnikow, 1865		2.9		1.6	
- <i>insigniformis</i> Greuter, 1917				0.8	
- <i>macrochaetus</i> Zelinka, 1889	5.5	0.1	15.1	6.6	24.1
- <i>macrolepidotus</i> Remane, 1927			1.6		
- <i>maximus</i> Ehrenberg, 1830			2.1		
- <i>octonarius</i> Stokes, 1887				1.3	
- <i>oculifer</i> Kisielewski, 1981		13.1	5.2	0.8	8.0
- <i>ophiogaster</i> Remane, 1927			2.5		
- <i>parafurcatus</i> Nesteruk, 1991		0.4	0.4	0.4	
- <i>persetosus</i> Zelinka, 1889	1.6	0.8		1.2	
- <i>polyspinosus</i> Greuter, 1917	7.5	21.0	0.8	2.5	
- <i>poznaniensis</i> Kisielewski, 1981			0.5		
- <i>similis</i> Zelinka, 1889	10.3	1.4	8.8	1.2	46.4
- <i>simrothi</i> Voigt, 1909					0.9
- <i>sphagnophilus</i> Kisielewski, 1981		8.1	0.5	4.5	3.6
- <i>spinulosus</i> Stokes, 1887				1.2	
<i>Heterolepidoderma</i> sp.			0.3	0.9	
- <i>gracile</i> Remane, 1927		4.4	17.1	1.2	
- <i>macrops</i> Kisielewski, 1981			0.7	27.9	
- <i>majus</i> Remane, 1927	9.5	4.0	0.8	3.7	
- <i>ocellatum</i> Mečnikow, 1865		4.4			
<i>Lepidodermella minor</i> Remane, 1935		1.8		1.2	0.9
- <i>squamata</i> Dujardin, 1841	24.5	7.9	9.4	32.4	
<i>Aspidiophorus oculifer</i> Kisielewski, 1981	6.7	4.6	2.1		
- <i>bibulbosus</i> Kisielewski, 1979		0.3			
- <i>ophiodermus</i> Balsamo, 1983					0.9
- <i>squamulosus</i> Roszczak, 1936	17.4	1.6	1.8		
<i>Ichthydium</i> sp.				0.4	
- <i>forficula</i> Remane, 1927		4.2	4.0		
- <i>palustre</i> Kisielewski, 1981		1.0	2.5		
- <i>podura</i> Müller, 1773	3.8	0.9		0.4	
<i>Polymerurus nodicaudus</i> Voigt, 1901		2.5			
Total	100.0	99.8	100.0	100.0	100.0
H'	2.19	2.88	2.56	1.49	2.01

**Table 2.** Fauna similarity, calculated according to the homogeneity coefficient (%). P – psammon, S – shore, L/S – littoral/sublittoral, PR – profundal, PL – plants

	P	S	L/S	PR	PL
P		25.7	28.8	16.5	36.0
S	25.7		28.3	9.9	24.7
L/S	28.8	28.3		27.3	17.1
PR	16.5	9.9	27.3		10.8
PL	36.0	24.7	17.1	10.8	

## DISCUSSION

The number of species recorded in the studied lake with developed zonality is higher than that given for lakes with a higher trophy [11] and higher than the number of species given by [18] for an oligotrophic Lake Mirror in the United States of America. In mountain oligotrophic lakes the number of gastrotrich species is even lower and amounts only to 14 [7]. This does not mean that *Gastrotricha* find the best living conditions in mesotrophic lakes. It is necessary to remember that Lake Piaseczno, considering its fully developed zonality, offers big environmental variety.

Data about dominance in freshwaters come only from Polish authors' papers [4,7,6,8,11,19]. Only some of them [7,11] refer to lakes, which hinders conclusions.

Among recorded eudominants, two of them, *Ch. macrochaetus* and *Ch. Similes*, were abundant in all the zones of the lake. *Ch. disiunctus* was not recorded only on submerged vegetation, and *L. squamata* was not present only in the lake profundal zone. *Ch. macrochaetus* and *Ch. disiunctus* were considered to be species belonging mainly to peat bogs [5], but they should be considered as eurytopic species because they were recorded in lakes of the Tatra and the Karkonosze Mountains [7] and in lakes on the Baltic coast [3]. Also *Ch. similis* and *L. squamata* were recorded in lakes of different types, so they belong to lacustrine species.

Comparison of the values of the species diversity index  $H'$  shows very close attractiveness of the shore zone and the littoral with sublittoral for *Gastrotricha*. Less attractive environment appeared to be the lake psammon zone and submerged vegetation, and the least attractive was the lake profundal. With reference to *Nematoda* species, diversity measured by the Shannon-Wiener index decreases with the increase of trophy, from oligo- to hypertrophy (Prejs [14]). This is connected with the worsening of oxygen conditions at the bottom. The number of gastrotrich species and the value of the  $H'$  index differ distinctly for the littoral with sublittoral zone and for the lake profundal (2.56 and 1.49 respectively). A gradual decrease in the nematode species richness as one moves from the

shallow littoral (5 species) to the sublittoral (27 species) to the profundal (10 species) was documented in the lake Mikołajskie [13].

Similarity of gastrotrich fauna of individual zones of the lake is low. The most separate fauna is that of the lake profundal, for which the mean value of the homogeneity index with the fauna of the rest of the zones amounts to only 16.12%.

### CONCLUSIONS

1. The research showed considerable diversity of species of *Gastrotricha* in a lake with developed zonality. The biggest species diversity of the fauna was recorded in the shore zone and in the littoral with sublittoral. For both the zones the highest value of the species diversity index  $H'$  was recorded (2.88 and 2.56), and the lowest – for the lake profundal (1.49).

2. Eudominants in the studied lake were 10 species; from that group two species – *Ch. macrochaetus* and *Ch. similis* were abundant in all the zones of the lake.

3. The research enabled the completion of the autecological characteristics of the following species: *Ch. disiunctus* and *Ch. macrochaetus* which had been considered to be species of peat bogs and which appeared to be common eurytopic species, and *Ch. similis* and *L. squamata* which are mainly lacustrine species.

### REFERENCES

1. **Kajak Z., Kacprzak K., Polkowski R.:** Tubular bottom sampler. Ekol. Pol., Ser. B, 11, 159-165, 1965.
2. **Kisielewska G.:** *Gastrotricha* of two complexes of peat hags near Siedlce. Fragm. Faun., 27, 39-57, 1982.
3. **Kisielewska G., Kisielewski J.:** Freshwater *Gastrotricha* of Poland. II. *Gastrotricha* from the seaside lakes In the Słowiński National Park. Fragm. Faun., 30, 183-194, 1986a.
4. **Kisielewska G., Kisielewski J.:** Freshwater *Gastrotricha* of Poland. III. *Gastrotricha* from the Białowieża Forest and the Białowieża Glade. Fragm. Faun., 30, 195-213, 1986 b.
5. **Kisielewski J.:** *Gastrotricha* from raised and transitional peat bogs in Poland. Monogr. Fauny Pol., 11, 143 pp, 1981.
6. **Kisielewski J.:** Freshwater *Gastrotricha* of Poland. VII. *Gastrotricha* of extremely eutrophicated water bodies. Fragm. Faun., 30, 267-295, 1986.
7. **Kisielewski J., Kisielewska G.:** Freshwater *Gastrotricha* of Poland. I. *Gastrotricha* from the Tatra and Karkonosze Mountains. Fragm. Faun., 30, 157-182, 1986.
8. **Nesteruk T.:** Freshwater gastrotricha of Poland. IV. *Gastrotricha* from fish ponds in the vicinity of Siedlce. Fragm. Faun., 30, 215-233, 1986.
9. **Nesteruk T.:** Vertical distribution of *Gastrotricha* in organic bottom sediment of inland water bodies. Acta Hydrobiol., 33, 253-264, 1991.
10. **Nesteruk T.:** Density and biomass of *Gastrotricha* in sediments of different types of standing waters. Hydrobiologia, 324, 205-208, 1996 a.

11. **Nesteruk T.:** Species composition and dominance structure of gastrotrich (*Gastrotricha*) assemblage in water bodies of different trophic status. *Hydrobiologia*, 339, 141-148, 1996 b.
12. **Nesteruk T.:** Epiphytic *Gastrotricha* – species composition and dominance. *Acta Hydrobiol.*, 42, 53-57, 2000.
13. **Prejs K.:** The littoral and profundal benthic nemathodes of lakes with different trophic. *Ekol. Pol.*, 25, 21- 30, 1977 a.
14. **Prejs K.:** The species diversity, numbers and biomass of benthic nemathodes in central part of lakes with different trophic. *Ekol. Pol.*, 25, 31-44, 1977 b.
15. **Riedl R.:** Probleme und Methoden der Erforschung des litoralen Benthos. *Verh. Dtsch. Zool.*, Suppl., 26, 505-567, 1963.
16. **Roszczak R.:** Chaetonoid *Gastrotricha* of Middle Great-Poland. [in Polish with English summary]. *Prace Komisji Biol. PTPN*, 32, 92 pp, 1968.
17. **Shannon C. E., Weaver W.:** The mathematical theory of communication. University of Illinois Press, Urbana, 117 pp, 1963.
18. **Strayer D.:** The benthic micrometazoans of Mirror Lake, New Hampshire. *Arch. Hydrobiol. Suppl.*, 72, 287-426, 1985.
19. **Szkutnik A.:** Freshwater *Gastrotricha* of Poland. VI. *Gastrotricha* of small astatic water bodies with rush vegetation. *Fragm. Faun.*, 30, 251-266, 1986.

## WPŁYW STREFOWOŚCI JEZIORA NA KSZTAŁTOWANIE SIĘ RÓŻNORODNOŚCI GATUNKOWEJ *GASTROTRICHA*

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**Streszczenie.** Badania prowadzono od wiosny do jesieni w latach 1994-2000 w mezzotroficznym jeziorze Piaseczno, położonym na Pojezierzu Łęczyńsko-Włodawskim. Dla badanych stref jeziora podano wskaźnik różnorodności gatunkowej  $H'$ , a podobieństwo fauny wyliczono na podstawie współczynnika homogeniczności [15]. W jeziorze stwierdzono łącznie 37 gatunków brzuchozęsków. W osadach dennych litoralu z sublitoralem występowały 22 gatunki, na roślinności 20, a w strefie psammonu jeziornego 11 gatunków *Gastrotricha*. Najniższą wartość  $H'$  uzyskano dla osadów dennych w strefie profundalu jeziora (1,49). Najbardziej odrębna fauna występuje w strefie profundalu, dla którego podobieństwo z fauną pozostałych stref wynosi od 9,9-27,3%. Eudominantami ( $D > 10\%$ ) w jeziorze było 10 gatunków brzuchozęsków. Łączna dominacja eudominantów w poszczególnych strefach jeziora wahała się od 34,1% (obrzeże) do 82,1% w profundalu. Przeprowadzone badania pozwalają uzupełnić charakterystykę autekologiczną następujących gatunków: *Chaetonotus macrochaetus* i *Ch. disiunctus*, stwierdzane wcześniej głównie na torfowiskach, okazały się pospolitymi gatunkami eurytopowymi, natomiast *Ch. similis* i *Lepidodermella squamata* są gatunkami głównie jeziornymi.

**Słowa kluczowe:** brzuchozęski, skład gatunkowy, dominacja