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ASSESSMENT OF THE TROPHIC STATE OF THE COASTAL LAKE GARDNO BASED ON COMMUNITY STRUCTURE AND ZOOPLANKTON-RELATED INDICES

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ABSTRACT

An analysis of the species composition of zooplankton of Lake Gardno was based on the materials collected in the years 1998–2002, from July to August. It was found that the numbers of zooplankton species, their abundance and biomass were greatly variable, and depended on abiotic factors and lake trophy. An analysis of the structural characteristics of zooplankton as bioindicators of lake eutrophication revealed the presence of some species of rotifers and crustaceans in the zooplankton community, considered good indicators of lake trophy. The zooplankton-related trophic state indices enabled to classify Lake Gardno as eutrophic and meso-eutrophic.

Key words: coastal lakes, estuaries, trophy, zooplankton, zooplankton-related trophic state indices.

INTRODUCTION

The occurrence of planktonic organisms under natural conditions is related to tolerance range (ecological optimum) dependent on abiotic environmental factors (temperature, oxygen concentration, pH), as well as on the biotic interactions among organisms. In the multidimensional space (ecological niche) the occurrence of organisms is affected by numerous environmental factors, both anthropogenic and non-anthropogenic [24, 37].

In coastal lakes, including Lake Gardno, zooplankton are strongly affected by abiotic environmental factors, such as time- and space-related salinity, water temperature, oxygen saturation, nutrient availability, water reaction, wave motion and inflow of biogenic substances from the catchment or brought with fluvial waters. These factors influence the species composition, densities and biomass of zooplankton and the occurrence of indicator species. Zooplankton communities are good bioindicators of the physical and chemical conditions of aquatic environments [10, 12, 17, 18, 27, 34]. The abundance of biogenic elements cause the development of forms typical of eutrophic waters, whereas thermal conditions – due to rapid changes in water temperature and salinity – have a selective effect, inhibiting development of communities [14, 28]. The fauna of brackish waters is usually characterized by species poverty, and dominated by species resistant to changing environmental conditions. Communities of euryhaline species of marine, freshwater and brackish-water origin, and typical brackish-water fauna are formed [6, 35, 44].

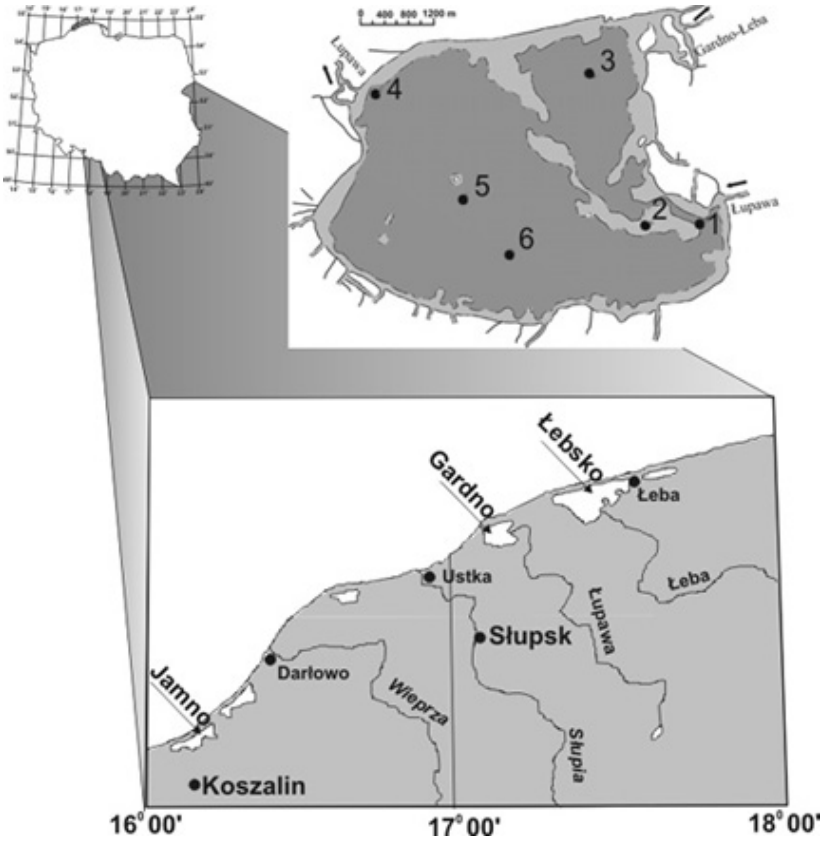
Coastal lakes are a specific mosaic of various habitats. These shallow and polymictic lakes are susceptible to degradation caused by anthropogenic factors, leading to their progressing eutrophication. The greatest load of pollutants, including biogenic substances, is brought with the inflow of fluvial waters [46] as well as with surface run-off from the agricultural catchment area [4, 23]. On the other hand, periodic intrusions of marine waters to estuaries inhibit eutrophication [4, 5, 45].

The paper presents the results of studies on the community structure, abundance and biomass of zooplankton in Lake Gardno, as dependent on variable abiotic environmental factors. The aim of the study was to test the hypothesis that changes in the communities of Rotifera and Crustacea may provide the basis for determining the trophic state of lakes.

MATERIALS AND METHODS

In Poland, in the immediate vicinity of the Baltic Sea, there are thirteen coastal lakes. One of them is Lake Gardno, situated in the Koszalin Coastland [21] (Fig. 1). This water body forms an estuary in the mouth section of the Łupawa River, which flows into this lake in its eastern part and flows out in the north-western end, and then flows into the Baltic Sea. Waters from smaller rivers and drainage ditches flow into the lake on the southern side. Lake Gardno covers a total area of 24.68 km^2 (Tab. 1a). This water body, as the majority of coastal lakes, is very shallow, with a mean depth of 1.3 m. The lake bottom is usually flat, the deepest hollow (2.6 m) is located in the south-eastern part of the lake. Almost the entire lake basin is covered by mud, ooze and deposits of a various thickness (to 2.5 m). The environment of Lake Gardno is characterized by physicochemical water parameters (Tab. 1b). In the summer surface water temperature ranges between 17 and 21°C. Water oxygenation is good due to constant mixing by the wind. The concentration of chloride ions is dependent on the inflow of freshwaters and marine waters. Water transparency varied between 0.5 – 0.8 m and is related to undulatory motion and phytoplankton development.

Fig. 1. Lake Gardno at the Polish Baltic Coast and location of sampling sites



An analysis of the zooplankton of Lake Gardno was based on the materials collected in the years 1998–2002 (July – August). Zooplankton samples were collected with a 5-liter Ruttner sampler in the whole water column, from the surface to the bottom. 25 to 50 liters of water were taken at six sampling sites (Fig. 1). The samples were collected at sites representing three different habitats (in each of the lakes concerned), i.e. dominated by the inflow of freshwaters, typical of the central part of the lake, and dominated by mixed fresh and salt waters. The zooplankton

samples were condensed using a plankton net and preserved with a Lugol's solution and then with a 40% ethyl alcohol. The physicochemical parameters of water (temperature, concentrations of oxygen and chloride, Secchi disc visibility) were determined by standard methods [38]. A total of 28 samples were taken over the study period.

Table 1a. Morphometric characteristics of Lake Gardno (Jańczak 1997)

Lake Parameters	Gardno
Elevation (m) a.s.l.	0.30
Area:	
Surface area (km^2)	24.68
islands area (km^2)	0.006
Catchment area (km^2)	964.4
Direct catchment area (km^2)	126
Depth:	
maximum (m)	2.6
mean (m)	1.3
Volume (mln m^3)	30.9

Table 1b. Variation (mean, range) in selected physico-chemicals parametres of water in Lake Gardno (number of samples – 28)

	Parameters			
Years	Temperature °C	Oxygen mg $O_2 \cdot dm^{-3}$	Chlorides mg $Cl^- \cdot dm^{-3}$	SDV** m
1998	14.1 (13.2-14.6)	9.5 (7.9-10.5)	481 (123-706)	1.0 (0.7-1.5)
1999	14.5 (13.6-15.1)	9.4 (8.8-9.9)	332 (82-688)	0.7 (0.7-0.8)
2000	17.3 (16.8-17.7)	8.8 (8.2-9.5)	338 (120-810)	0.6 (0.5-0.75)
2001	17.3 (17.0-17.7)	8.6 (8.4-8.8)	320 (120-701)	0.7 (0.6-0.8)
2002	20.7 (19.9-21.0)	8.6 (8.5-8.8)	321 (120-706)	0.6 (0.6-0.65)

* according to Department of Environmental Chemistry, Pomeranian Pedagogical University of Slupsk
** Secchi Disk Visibilty

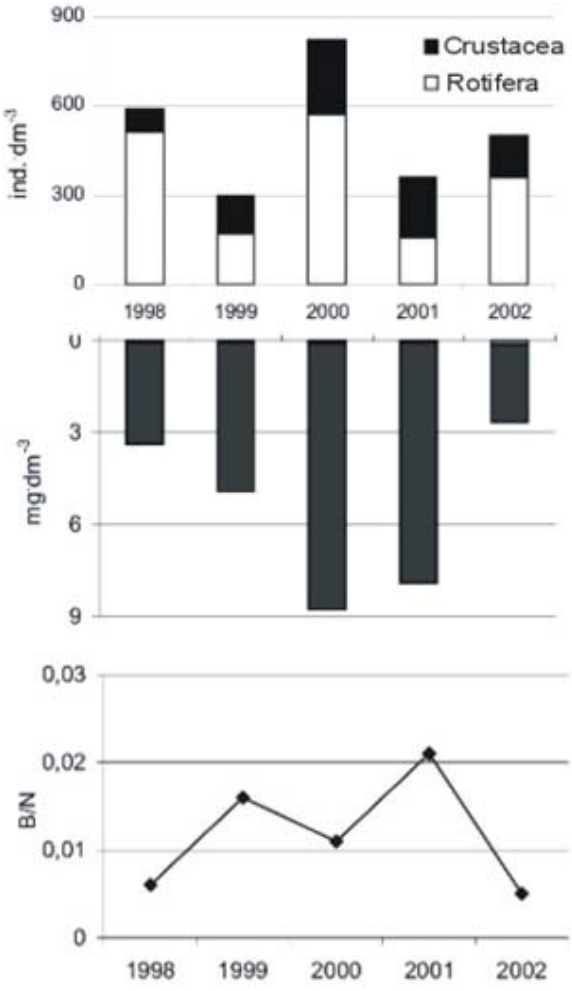
The abundance of planktonic organisms was calculated using the Hensen formula [41]. The biomass of rotifers and crustaceans was estimated as recommended by Hillbricht-Ilkowska and Patalas [13], and Bottrell et al. [1]. The indices of zooplankton species diversity follow Krebs [22], zooplankton-related trophic state indices – Radwan [34] and Karabin [17, 18], and the trophic state index (TSI_{SD}) – Carlson [3].

The results of the study, in the form of the calculated indices, were analyzed statistically using Statistica *PL* 6.0 software, and interpreted as recommended by Stanisz [40]. The quantitative parameters of zooplankton were determined by a principal component analysis (PCA) performed on data arranged in a correlation matrix. The aim of the analysis was to verify the statistical significance of correlations between the abundance of zooplankton species, and environmental variables. In order to determine significant sources of variation ($p<0.05$), means were compared by the HSD-based Tukey test.

RESULTS AND DISCUSSION

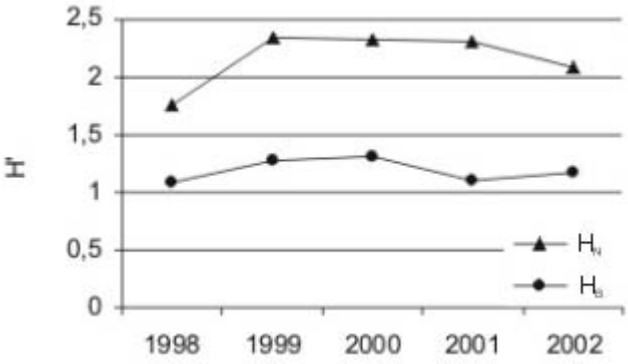
The abundance of summer zooplankton (Rotifera and Crustacea) in Lake Gardno in the years 1998–2002 ranged between 299 and 823 indiv.·dm^{-3} (Fig. 2). The most numerous rotifer communities (512 and 571 indiv.·dm^{-3}), indicating eutrophy [17, 34], were recorded in 1998 and 2000, whereas in the other years of the study period their densities were characteristic of meso-eutrophy (<400 indiv.·dm^{-3}; Karabin [17]). The numbers of crustaceans indicated the mesotrophic character of lake waters (75-200 indiv.·dm^{-3}), except the year 2000 when their abundance was higher (252 indiv.·dm^{-3}). The abundance of rotifers increases with an increase in lake trophy, whereas the abundance of crustaceans increases only between mesotrophy to meso-eutrophy [17, 18]. Zooplankton abundance was determined by rotifers, and zooplankton biomass – by crustaceans, and an increase in abundance not always corresponded to an increase in biomass (Fig. 2). The ratio between zooplankton biomass and numbers increased with an increase in crustacean biomass, and decreased along with an increase in rotifer abundance (Fig. 2). Rotifer biomass shows a rising tendency in the mesotrophy to eutrophy range, but there is no correlation between crustacean biomass and the trophic state of lakes [17, 18]. These relationships were only partly confirmed by the results of the present study. In 1999 in Lake Gardno Rotifera biomass was 0.053 mg·dm^{-3} for the meso-eutrophic state of water, and in 2000 it was almost twofold higher for the eutrophic state. Crustacean biomass increased according to a similar pattern – it amounted to 9 mg·dm^{-3} for eutrophic waters, and ranged from 2 to 7 mg·dm^{-3} for mesotrophic waters. According to Karabin [17], zooplankton abundance above 2000 indiv.·dm^{-3}, as well as the ratio between rotifer biomass and abundance (<0.000015) and between crustacean biomass and abundance (>0.05-0.06), are among the criteria of trophic state assessment in lakes. This conclusion was also confirmed by Parpala et al. [29], who studied Lake Balaton, and by Lovik and Kjellberg [26], who examined the Norwegian Lake Mjosa. Trophy relations in lakes are the main factor determining the abundance, biomass and community structure of zooplankton [7, 8, 9, 12, 27, 34, 42, 43].

Fig. 2. Numbers (indiv. · dm^{-3}) and biomass (mg · dm^{-3}) of Rotifera and Crustacea and the zooplankton biomass to numbers ratio (B/N) in Lake Gardno in the years 1998-2002



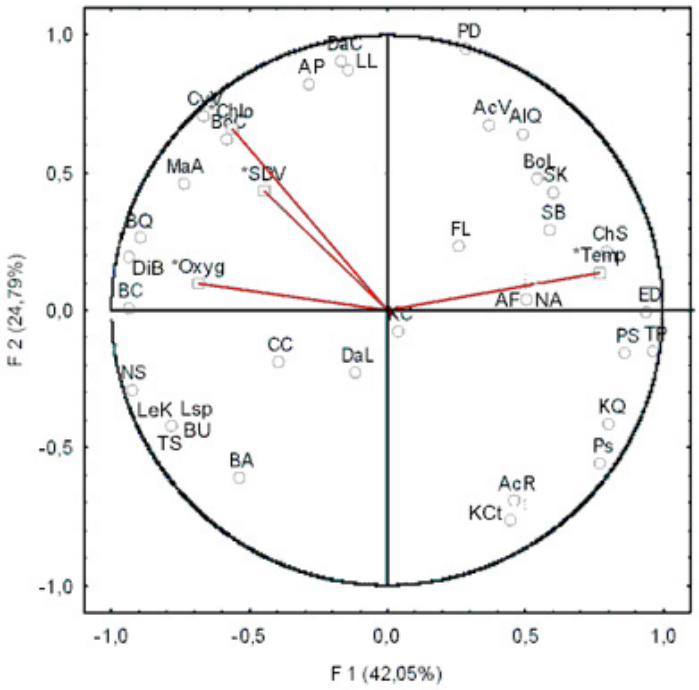
Species diversity measured by the Shannon index is directly proportional to the number of species in the sample and the uniformity of species distribution in the total abundance and biomass [22]. In Lake Gardno the species diversity of zooplankton (Fig. 3) was relatively high (H_N= 2.08 – 2.35; H_B=1.09 – 1.31), which indicates both good environmental conditions, conducive to the development of many species, and – according to Kajak [16] – moderate trophy of waters. Only in 1998 the values of H_N and H_B were much lower, which was reflected by the lowest recorded number of species in the zooplankton community (14), as well as by the domination of single species, accompanied by low proportions of other taxa. This indicated more advanced trophy of the lake. The hypothesis that an increase in trophy is followed by community structure simplification was also confirmed by Rogozin [36], who studied selected structural parameters of zooplankton in lakes differing in trophic status.

Fig. 3. Changes in the values of the species diversity index for the numbers (H_N) and biomass (H_B) of the zooplankton in Lake Gardno in the years 1998-2002



The community structure of the summer zooplankton in Lake Gardno comprised 22 Rotifera species and 12 Crustacea species (Table 2). The number of taxa and community structure of zooplankton varied widely over the study period, depending on environmental conditions (Fig. 4). Among the factors analyzed, factor 1 and factor 2 (the correlation between the occurrence and abundance of zooplankton species, and environmental parameters) explained 66.8% of variation. The analysis of environmental variables showed that the occurrence of zooplankton species in particular years of the study was correlated negatively with water transparency, water oxygen content and concentrations of chloride ions, and positively with temperature. The relationships between the occurrence and densities of zooplankton species, and abiotic environmental factors varied widely. Spatial and seasonal distribution of planktonic fauna in the Zeeschelde estuary was dependent on temperature and salinity [28], just like in Lake Łebsko [32]. However, according to Hall et al. [10], salinity is the main factor differentiating zooplankton communities in coastal lakes. The diagram of PCA results (Fig. 4) shows that among the zooplankton groups examined in the study, the occurrence of rotifers in Lake Gardno depended on water temperature (p=0.000), whereas the occurrence of crustaceans – on water transparency, the concentrations of oxygen and chloride ions (p=0.000). A significant positive correlation (values approaching 1.0) was observed for rotifers and crustaceans – indicator species of high trophy levels, *Keratella cochlearis* f. *tecta, Keratella quadrata*, *Proales* sp., *Pompholyx sulcata*, *Trichocerca pusilla*, *Bosmina longirostris*, *Chydorus sphaericus*, and low correlations were recorded for *Anuraeopsis fissa* and *Filinia longiseta*. A strong negative correlation (values approaching – 1.0) was found for one rotifer species, *Brachionus angularis,* and two crustacean species, *Bosmina coregoni* and *Diaphanosoma brachyurum*. The results of an analysis of the occurrence and abundance of zooplankton species in particular years of the study in Lake Gardno (Fig. 5) indicated that in the years 2001 – 2002 they were negatively correlated with variation-explaining factors, while in the years 1998 – 2000 – positively. These relationships were statistically significant (p=0.000). These relationships were weaker in the years 1998 – 2000 (projection of cases-years in the range of 1 – 4 on a 8-point scale), and stronger in the years 2001 – 2002 (projection of cases-years in the range of 3 – 6).

Fig. 4. Diagram of PCA results – zooplankton species occurrence in Lake Gardno in the years 1998–2002, as dependent upon environmental factors



Taxa abbrevations/Active variables: *Anuraeopsis fissa* (AF), *Asplanchna priodonta* (AP), *Brachionus angularis* (BA), *Brachionus calyciflorus* (BC), *Brachionus quadridentatus* (BQ), *Brachionus urceolaris* (BU), *Colurella colurus* (CC), *Euchlanis dilatata* (ED), *Filinia longiseta* (FL), *Kellicotia longispina* (KL), *Keratella cochlearis* (KC), *Keratella cochlearis* f. *tecta* (KCt), *Keratella quadrata* (KQ), *Lecane luna* (LL), *Lepadella* sp. (Lsp), *Notholca acuminata* (NA), *Notholca squamula* (NS), *Polyartha dolichoptera* (PD), *Pompholyx sulcata* (PS), *Proales* sp. (Psp), *Synchaeta baltica* (SB), *Synchaeta kittina* (SK), *Trichocerca pusilla* (TP), *Trichocerca similis* (TS); *Alona quandrangularis* (AlQ), *Bosmina coregoni* (BoC), *Bosmina longirostris* (BoL), *Chydorus sphaericus* (ChS), *Daphnia cucullata* (DaC), *Daphnia longispina* (DaL), *Diaphanosoma brachyurum* (DiB), *Leptodora kindtii* (LeK), *Acanthocyclops robustus* (AcR), *Acanthocyclops vernalis* (AcV), *Cyclops vicinus* (CyV), *Mesocyclops albidus* (MaA) Environmental variables: temperature (temp), oxygen (oxyg), chlorides (chlo), Secchi Disk Visibility (SDV)

Fig. 5. Diagram of PCA components – ordering of zooplankton samples collected in Lake Gardno in the years 1998-2002

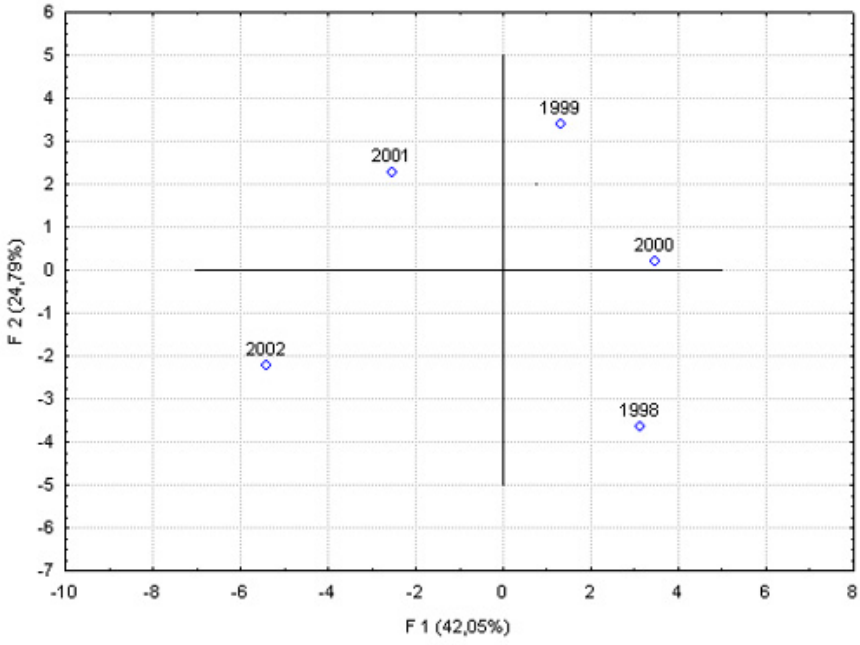


Table 2. List of Rotifera and Crustacea species found in the zooplankton in the summer in Lake Gardno (number of samples – 28)

Year Rotifera:	1998	1999	2000	2001	2002
Anuraeopsis fissa Gosse			*		
Asplanchna priodonta Gosse	+	+	+	+	+
Brachionus angularis Gosse	*	*	*	*	*
Brachionus calyciflorus Pallas				+	+
*Brachionus quadridentatus*Hermann		+		+	+
Brachionus urceolaris Linnaeus					+
Colurella colurus Ehrenberg		+	+		+
Euchlanis dilatata Ehrenberg	+	+	+		
Filinia longiseta Ehrenberg		*	*		*
Keratella cochlearis cochlearis Gosse	+	+	+	+	+
Keratella cochlearis f. *tecta* Gosse	*	*	*	*	*
Keratella quadrata O.F.Müller	*	*	*	*	
Lecane luna O.F.Müller		+		+	
Lepadella sp.					+
Notholca acuminata Ehrenberg			+		
Notholca squamula O.F.Müller				+	+
Polyartha dolichoptera Idelson		+	+	+	
Pompholyx sulcata Hudson	*	*	*	*	*
Proales sp.	*	*	*		
Synchaeta baltica Ehrenberg		+	+		
Synchaeta kitina Rousselet		+	+		
Trichocerca pusilla Lauterborn	*	*	*		
Trichocerca similis Wierzejski					+
Crustacea:					
Alona quadrangularis O.F.Müller		+	+		
Bosmina coregoni Baird		*	*	*	*
Bosmina longirostris O.F.Müller	*	*	*	*	
Chydorus sphaericus O.F.Müller	*	*	*	*	*
Daphnia cucullata Sars	+	+	+	+	+
Daphnia longispina O.F.Müller	+	+	+	+	+
Diaphanosoma brachyurum Liévin		*	*	*	*
Leptodora kindtii Focke	+	+	+	+	+
Acanthocyclops robustus G.O.Sars	+				
Acanthocyclops vernalis Fischer		+	+	+	
Cyclops vicinus Uljanin		+	+	+	+
Macrocyclops albidus Jurine		+		+	+
Copepoda juv.	+	+	+	+	+
Total	**14**	**26**	**25**	**20**	**20**

* – indicator species of trophic state (according to Karabin 1985a)

The lowest number of zooplankton species was recorded in Lake Gardno in 1998. In 1999 and 2000 their number was almost twofold higher (Table 2). This fact may be explained by varied salinity levels in particular years (Table 1b). As a result, specialized communities are formed, in which qualitative development is replaced by rapid quantitative development of highly tolerant species. Many rotifer and crustacean species show a wide tolerance range to environmental changes, and may constitute an indicator of trophic state [17, 25, 30, 33, 34]. The

zooplankton community of Lake Gardno (Table 2) included eight rotifer species (*Anuraeopsis fissa*, *Brachionus angularis*, *Filinia longiseta*, *Keratella cochlearis* f. *tecta*, *Keratella quadrata*, *Pompholyx sulcata*, *Proales* sp., *Trichocerca pusilla*) and four crustacean species (*Bosmina coregoni*, *Bosmina longirostris*, *Chydorus sphaericus*, *Diaphanosoma brachyurum*), which formed ecological group II (species whose proportion in the total biomass of a given community is very high, indicators of high trophy, typical of eutrophicated water bodies; their domination and percentage in the plankton increase along with increasing trophy levels), typical of eutrophicated waters [17].

An analysis of the species composition of the Rotifera and Crustacea communities in Lake Gardno, as well as their contribution to the total zooplankton abundance and biomass, revealed that a few of them (>5%) formed large populations, determining the numbers and biomass of the zooplankton (Figs. 6a, 6b). In terms of numbers, the most common dominants in the Rotifera community were *Keratella cochlearis* f. *tecta*, *Brachionus angularis* and *Pompholyx sulcata* – indicators of high trophy [17]. *Daphnia cucullata,* which is not an indicator of trophic status, dominated in terms of biomass [2, 25, 31]. *Daphnia longispina* co-dominated twice (1998 and 2001). Both species have similar nutrient requirements, so they cannot occupy the same ecological niche. *Daphnia cucullata* occurs in great numbers in the surface layer, and *Daphnia longispina* – in deeper layers [11, 27].

Fig. 6a. Dominance structure of Rotifera communities – numbers (N) and biomass (B) – in the zooplankton of Lake Gardno (>5%) in the years 1998–2002

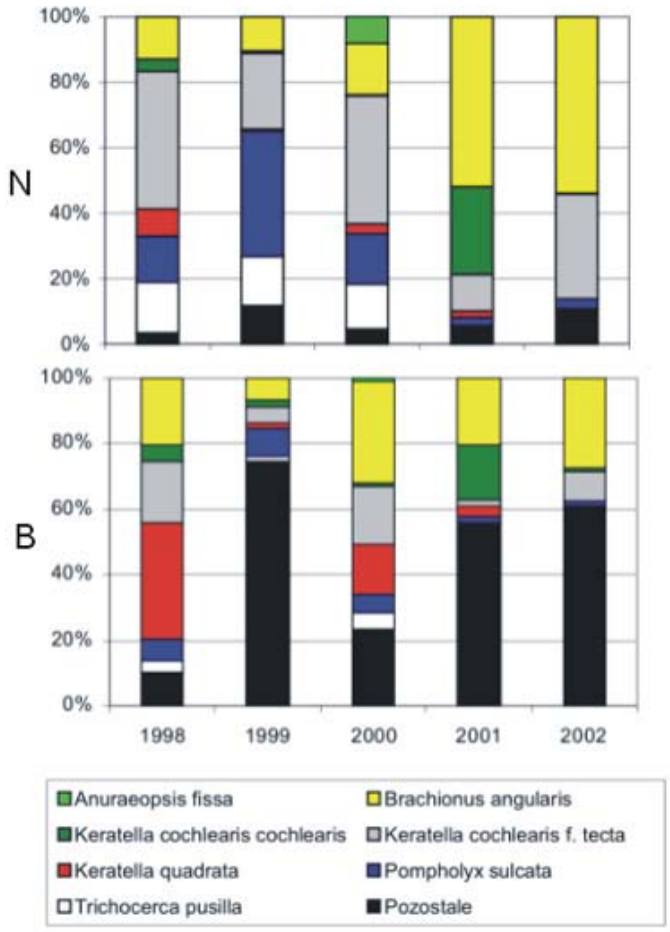
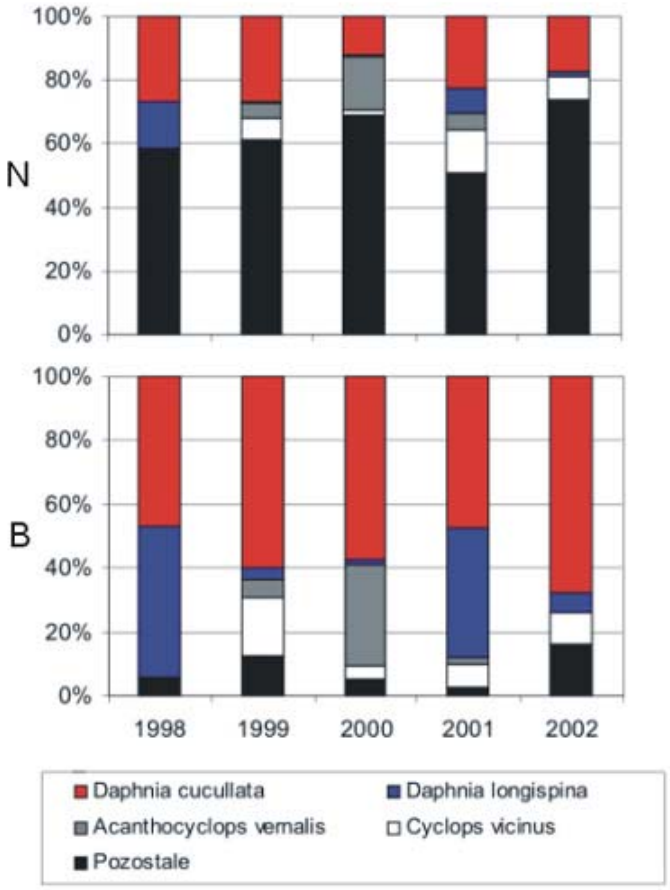


Fig. 6b. Dominance structure of Crustacea communities – numbers (N) and biomass (B) – in the zooplankton of Lake Gardno (>5%) in the years 1998–2002



In order to assess the trophic state of Lake Gardno many structural characteristics of zooplankton were determined in the form of trophic state indices proposed by Radwan [34] and Karabin [17, 18], which were found to be good tools for lake classification (Table 3). One of the key indices applied to lakes representing various limnological types is the trophic state index based on Secchi disk transparency (TSI_{SD}). This is a reliable tool [3, 39] – the range of its variation is relatively wide and includes all stages of water eutrophication, it is independent of lake morphometry and mictic type. The commonly applied trophic state indices, such as concentrations of phosphates and chlorophyll, and primary production, reflect the situation in a water body only at the moment the measurement is performed [17]. According to the trophic state index (TSI_{SD}), Lake Gardno should be classified as eutrophic. The proportion of the *tecta* form in the *Keratella cochlearis* population indicated more advanced trophy, i.e. polytrophy. The contribution of ecological group II to the biomass of the indicatory rotifer community enabled to classify Lake Gardno as meso-eutrophic, whereas the contribution of ecological group II to crustacean biomass – as mesotrophic. The other structural characteristics of zooplankton, based on rotifer abundance, the contribution of Cyclopidae to the biomass of Crustacea and the ratio between the Cyclopidae biomass and the Cladocera biomass, allowed to classify Lake Gardno as meso-eutrophic with symptoms of eutrophy or mesotrophy.

Table 3. Zooplankton-based indices of the trophic state of Lake Gardno: TSI_{SD} (Carlson 1977), proportion of ecological group II in the biomass of the indicator rotifer community (%, group II – Rotifera), proportion of *tecta* in the biomass of *Keratella cochlearis* (%, TECTA), abundance of rotifers (indiv. · dm^{-3}, Rotifera N), proportion of ecological group II in the biomass of the indicator crustacean community (%, group II – Crustacea), proportion of Cyclopidae in the biomass of Crustacea (%, Cyclopidae in B Crust.), ratio between Cyclopidae biomass and Cladocera biomass (mg · dm^{-3}, B_{CY}:B_{CL}) and ranges of values for trophic types of lakes (Karabin 1985a)

Year	TSI_{SD}	II group Rotifera	TECTA	Rotifera N	II group Crustacea	Cyclopidae in B Crust.	B_{CY} : B_{CL}
1998	60	86.4	78.6	512	1.64	1.76	0.018
1999	65	28.3	100	170	8.42	25.3	0.339
2000	67	81.5	93.8	571	2.53	36.8	0.582
2001	65	27.8	9.1	159	1.21	9.94	0.110
2002	67	40.3	100	361	8.64	12.8	0.146
Trophic types	Ranges of values						
Mesotrophy	<45	<10	0-5	<400	<25	<15	<0.2
Meso-eutrophy	45-55	10-90	5-20	<400	25-60	15-30	0.2-0.8
Eutrophy	55-65	>90	20-60	400-2000	>60	>30	>0.8
Polytrophy	>65	>90	>60	>2000	-	-	-

In order to assess the trophy state of Lake Gardno on the basis of zooplankton-related indices, two five-year periods were compared (Table 4). A distinct improvement in water state took place in the years 1998–2002, as compared with the 1985–1989 period. Only the proportion of the *tecta* form in the *Keratella cochlearis* population still indicated polytrophy of this lake. The other structural characteristics of zooplankton, used in the study as bioindicators of the eutrophication process at two stages of research (1985–1989 and 1998 – 2002) may be presented as follows:

TSI_{SD}: polytrophy – eutrophy
Ecological group II of Rotifera: eutrophy – meso-eutrophy
Rotifera N: eutrophy – meso-eutrophy/eutrophy
Ecological group II of Crustacea: mesotrophy – mesotrophy
Cyclopidae in B Crust.: eutrophy/meso-eutrophy – mesotrophy/meso-eutrophy
B_{CY}:B_{CL}: meso-eutrophy – mesotrophy/meso-eutrophy.

Table 4. Comparison of the trophic state of Lake Gardno in the years 1985–1989 and 1998-2002 based on zooplankton-related indices* (water trophic type*: m – mesotrophy, me – meso-eutrophy, e – eutrophy, p – polytrophy)**

Year	Trophic water type						
	TSI_{SD}	Zooplankton-based indices of the trophic state					
		II group Rotifera	TECTA	Rotifera N	II group Crustacea	Cyclopidae in B Crust.	B_{CY} : B_{CL}
1985	polytrophy	me	p	e	m	e	e
1986		e	p	e	m	e	me
1987		e	p	e	me	me	me
1988		e	p	e	m	me	me
1989		e	p	e	m	e	me
1998	eutrophy	me	p	e	m	m	m
1999		me	p	me	m	me	me
2000		me	p	e	m	me	me
2001		me	me	me	m	m	m
2002		me	p	me	m	m	m

* according to Karabin (1985a); symbols as in Table 3
** according to Paturej and Gozdziejewska (in press)

Advanced eutrophication can be observed primarily in shallow, polymictic lakes [19, 20]. Coastal lakes, including Lake Gardno, are characterized by such morphometry. They are susceptible to degradation caused by anthropogenic factors, and constitute natural “settling sinks” for most pollutants brought by rivers flowing through them and than into the Sea. Deep, stratified lakes, like those situated in the Suwałki Lakeland, are much more resistant to eutrophication.

CONCLUSIONS

1. The number of taxa in the zooplankton community in Lake Gardno varied widely over the study period, depending on environmental conditions. The occurrence of Rotifera was related to water temperature, whereas the occurrence of Crustacea – to the concentrations of oxygen and chloride ions in water.
2. In the estuary studied zooplankton abundance was dominated by rotifers, and zooplankton biomass – by crustaceans.
3. The zooplankton community in Lake Gardno included several species of rotifers and crustaceans, which are good indicators of the trophic state of waters. They belong to the so called ecological group II, comprising eight taxa of Rotifera: *Anuraeopsis fissa*, *Brachionus angularis*, *Filinia longiseta*, *Keratella cochlearis* f. *tecta*, *Keratella quadrata*, *Pompholyx sulcata*, *Proales* sp., *Trichocerca pusilla* and four species of Crustacea: *Bosmina coregoni*, *Bosmina longirostris*, *Chydorus sphaericus*, *Diaphanosoma brachyurum*.
4. The trophic state of Lake Gardno was assessed based on zooplankton-related trophic state indices: the proportion of the *tecta* form in the *Keratella cochlearis* population indicated polytrophy; contribution of ecological group II to the biomass of the indicatory rotifer community – meso-eutrophy, ecological group II of crustaceans suggested mesotrophy, whereas the abundance of rotifers, the contribution of Cyclopidae to the biomass of Crustacea as well as the ratio between the Cyclopidae biomass and the Cladocera biomass – meso-eutrophy with symptoms of eutrophy or mesotrophy.
5.

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