CHANGES IN ROTIFERA FAUNA OF KOVADA LAKE (TURKEY) BETWEEN 1998 AND 2006

GÜLLE İskender, YILDIRIM Mehmet Zeki, ERTAN Ömer Osman

Abstract. Qualitative and quantitative studies on rotifer fauna of shallow and eutrophic Kovada Lake were performed to elucidate changes in the fauna in response to increasing levels of eutrophication between 1998 and 2006. According to our results, the number of rotifer taxa has decreased by half (from 40 to 20), while the mean density has increased 20.42 times (45.42 to 973.21 ind.l^{-1}). These changes may be interpreted as consequences of considerable changes in trophic levels and decreasing water quality; indirect effects like the suppression of submerged plant growth by decrease of transparency could also be effective.

Keywords: Rotifera, eutrophication, Kovada Lake, water quality.

Rezumat. Schimbări ale faunei de rotifere din Lacul Kovada (Turcia) în perioada 1998-2006. Studiile calitative şi cantitative privind fauna de rotifere din Lacul Kovada, un lac puțin adânc şi eutrofizat, au fost făcute pentru a elucida schimbările faunei induse de nivelul de eutrofizare în creştere înregistrat între 1998 şi 2006. Conform rezultatelor noastre, numărul de taxoni de rotifere a scăzut la jumătate (de la 40 la 20), în timp ce densitatea medie a crescut de 20,42 ori (de la 45,42 la 973.21 ind.l^{-1}). Aceste modificări pot fi interpretate drept consecințe ale schimbărilor considerabile survenite la nivel trofic, precum şi ale scăderii calității apei; efectele indirecte, precum suprimarea creşterii plantelor submerse ca urmare a scăderii transparenței pot avea, de asemenea, un rol important.

Cuvinte cheie: Rotifera, eutrofizare, lacul Kovada, calitatea apei.

INTRODUCTION

Kovada Lake (37°40′N-30°52′E) is situated in Isparta province, near the southern limit of Lakes Region. The lake is of tectonic-karstic origin and it lies at the center of a graben area, Bozova or Kovada graben, within Western Taurus Mountains. The surface is about 8.5 km^2 and altitude is 904.5 m. The lake has a $21x10^6$ m^3 water volume, while the drainage area is around 77 km^2. Climatically, the area is within the Mediterranean climatic zone (ANONYMOUS, 1998; ATAYETER, 2005).

The lake and surrounding forest area has been declared national park in 1970. However, especially in the recent period, trophic level has increased significantly in the normally shallow eutrophic lake covered with submerged vegetation. Nutrients and pollutants are carried to the lake by direct surface flow from extensive orchards in afforested lowlands covering most of the catchment area and through Kovada irrigation canal to which the sewage of Eğirdir town is discharged directly.

In aquatic environments, generally, rotifers become dominant in abundance and species numbers increase in case of higher trophic levels. As rotifers are highly adaptive and responsive to abiotic changes, due to small body size and high metabolic rates (STARKWEATHER, 1996), they have been known to play an important role as indicator species in assessment of water quality and eutrophication (TELESH, 1999) and determination of trophic and saprobic levels (RADWAN, 1976; KLEE, 1991).

In the study, we aim at determining the medium term changes in the Rotifera fauna of Kovada Lake to assess the effects of increasing trophic levels in the lake.

MATERIAL AND METHODS

Sampling was carried out in 1998 (5 stations) and in 2006 (3 stations) on monthly basis. Zooplankton samples and samples for water quality analyses were collected from three stations (Fig. 1), at surface water using Nansen bottles (1.7 l volume). In water quality analyses, it was used the methodology described by APHA-AWWA-WEF (1998) and BOYD & TUCKER (1992).

Zooplankton were filtered with plankton net of 55µm mesh size and preserved in 4% formalin. Rotifer counts were carried out in Sedgwick-Rafter counting chambers under an inverted microscope at 200x magnification (Nikon Eclipse TE-200) as described by APHA-AWWA-WEF (1998). Rotifers were identified to species using the available literature (KOSTE, 1978a, b; PONTIN, 1978; RUTNER-KOLISKO, 1974). Rotifers abundance was expressed as individuals per liter.

RESULTS AND DISCUSSIONS

The lake showed typical features of the eutrophic lakes in 1998. According to the observations during field studies in 1998, aquatic macrophytic flora was composed of *Schoenoplectus lacustris* (L.) PALLA, *Thypha laxmannii* LEPECH., *Scirpoides holoscheoenus* (L.) SOJAK, *Potamogeton panormitanus* BIV., *P. crispus* L., *Ceratophyllum demersum* L., *Eleocharis palustris* (L.) ROEM. & SCHULT., *Butomus umbellatus* L., *Ranunculus saniculifolius* VIV,

Phragmites australis (CAV.) TRIN. EX STEUD., *Myriophyllum spicatum* L., *Vallisneria spiralis* L., and *Chara* sp. In 2006 surveys, coverage of the submerged plant taxa in the lake was lower as compared to previous observations in the stations. Also, in 2006, *Microcystis aeruginosa* (KUTZING) KUTZING blooms were observed as a clear evidence for the increase of eutrophication.

Stizostedion lucioperca (LINNAEUS 1758) (pike perch), *Cyprinus carpio* (LINNAEUS 1758) (carp), *Vimba vimba tenella* (NORDMANN 1840) (vimba) and *Astacus leptodactylus salinus* (NORDMANN 1842) (Turkish crayfish) were reported previously in the lake, but according to the observations during the study period it seems that *Carassius gibelio* (Prussian carp), *Gambusia affinis* (BAIRD & GIRARD 1853) (mosquito fish), and *Knipowitschia caucasica* (BERG 1916) (Caucasian goby) also existed in the lake.

The results of water quality parameters obtained in years 1998 and 2006 from monthly samplings are rendered below (Table 1). According to Wollenweider and OECD criteria (HARPER, 1992), changes in conductivity, Secchi disc depth, PO_4-P and Chl. *a* values indicate that the trophic level of the lake has increased in 2006 as compared to 1998 (Table 1).

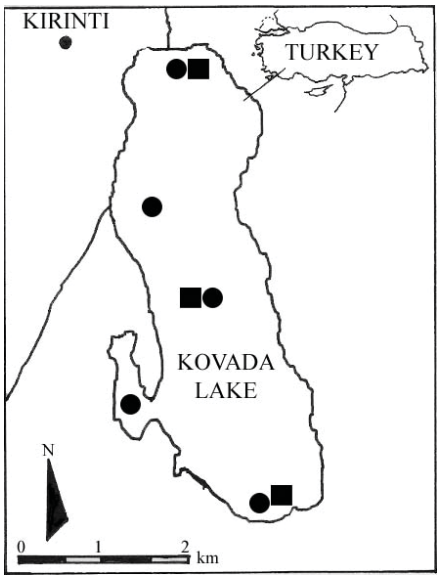

Figure 1. Map of study area: dark circles-stations in 1998, dark squares-stations in 2006.
Figura 1. Harta zonei studiate: cercurile – punctele de prelevare din 1998, pătratele – punctele de prelevare din 2006

Table 1. Mean physio-chemical features of Kovada Lake in 1998 and 2006.
Tabel 1. Caracteristicile fizico-chimice medii ale Lacului Kovada între 1998 şi 2006.

Parameters	Years	
	1998	2006
Temperature (°C)	15.2	13.5
pH	9.34	8.5
Dissolved oxygen (mg l^{-1})	9.7	9.7
Dissolved oxygen sat. (%)	105.6	99.9
Conductivity (25°C µS/cm)	266	374
Secchi disc depth (m)	1.89	0.81
Depth (m)	2.90	2.63
Cl (mg l^{-1})	11.1	7.91
Alkalinity (as $CaCO_3$) (mg l^{-1})	167	186
Hardness (as $CaCO_3$) (mg l^{-1})	160	215
Organic matter (as $KMnO_4$) (mg l^{-1})	17.9	-
SO_4 (mg l^{-1})	7.75	-
NO_3-N (mg l^{-1})	1.138	0.219
PO_4-P (mg l^{-1})	0.021	0.087
Turbidity (NTU)	-	14.8
Total suspended solids (mg l^{-1})	-	14.2
Chl. *a* (µg l^{-1})	5.82 (1.00-35.10)*	8.93(1.57-14.48)*

(*) : min. - max. value

The rotifer taxa determined from the samplings of 1998 and 2006 are presented below in Table 2. Totally, 40 species were determined in 1998, while only 20 species could be detected in 2006. Thus, a significant decline in species richness despite the increasing trophic levels was observed from 1998 to 2006.

Quantitatively, mean rotifer densities in 1998 and 2006 were found to be 45.42 and 973.21 ind. l^{-1} respectively (Fig. 2). Thus, an increase in density by 20.42 times occurred in the 8 year period between 1998 and 2006. In 2006, proportions of *P. vulgaris* and *K. cochlearis* in the population were found to be 27% and 25% respectively (Fig. 3).

Table 2. Species composition of Rotifera in 1998 and 2006.
Tabel 2. Compoziția speciilor de rotifere în 1998 şi 2006.

Species	Years		Species	Years	
	1998	2006		1998	2006
Anuraeopsis fissa (GOSSE 1851)	+	-	*L. nana* (MURRAY 1913)	+	-
Asplanchna priodonta GOSSE 1850	+	+	*L. quadridentata* (EHRENBERG 1832)	+	-
Asplanchnopus sp.	+	-	*Lepadella ovalis* (MULLER 1786)	+	+
Brachionus patulus (MULLER 1876)	+	-	*Monommata* sp.	-	+
B. quadridentatus (HERMAN 1873)	+	-	*Mytilina mucronata* (MULLER 1773)	+	-
B. urceolaris (MULLER 1773)	+	-	*M. ventralis* (EHRENBERG 1832)	+	-
Cephalodella gibba (EHRENBERG 1838)	+	-	*Notholca acuminata* (EHRENBERG 1832)	+	+
Colurella adriatica EHRENBERG 1830	+	-	*Notholca squamula* (MULLER 1786)	+	+
C. colurus (EHRENBERG 1830)	+	-	*Platyas quadricornis* (EHRENBERG,1832)	+	-
Conochilus coenobasis SKORIKOV 1914	+	+	*Polyarthra vulgaris* CARLIN 1943	+	+
Euchlanis deflexa GOSSE 1851	+	-	*Pompholyx sulcata* (HUDSON 1885)	-	+
Filinia longiseta (EHRENBERG 1834)	+	+	*Rotaria neptunia* (EHRENBERG 1832)	+	-
Hexarthra mira (HUDSON 1871)	+	+	*Synchaeta oblonga* EHRENBERG 1831	+	+
Keratella quadrata (MULLER 1786)	+	+	*S. pectinata* EHRENBERG 1832	+	+
K. cochlearis (GOSSE 1851)	-	+	*Scaridium longicaudum* (MULLER, 1786)	+	-
K. testudo (EHRENBERG 1832)	-	+	*Testudinella patina* (HERMANN 1783)	+	-
K. tropica (APSTEIN 1907)	-	+	*Trichocerca bicristata* (GOSSE 1887)	+	-
Lecane bulla (GOSSE 1851)	+	-	*T. longiseta* (SCHRANK 1802)	+	-
L. closterocerca (SCHMARDA 1859)	+	+	*T. pusilla* (JENNINGS 1903)	-	+
L. curvicornis (MURRAY 1913)	+	-	*T. similis* (WIERZEJSKI 1893)	-	+
L. flexilis (GOSSE 1886)	+	-	*Trichocerca* sp.	+	-
L. luna (MULLER 1776)	+	-	*Trichotria pocillum* (MULLER 1776)	+	-
L. lunaris (EHRENBERG 1832)	+	-	*T. tetractis* (EHRENBERG 1830)	+	+

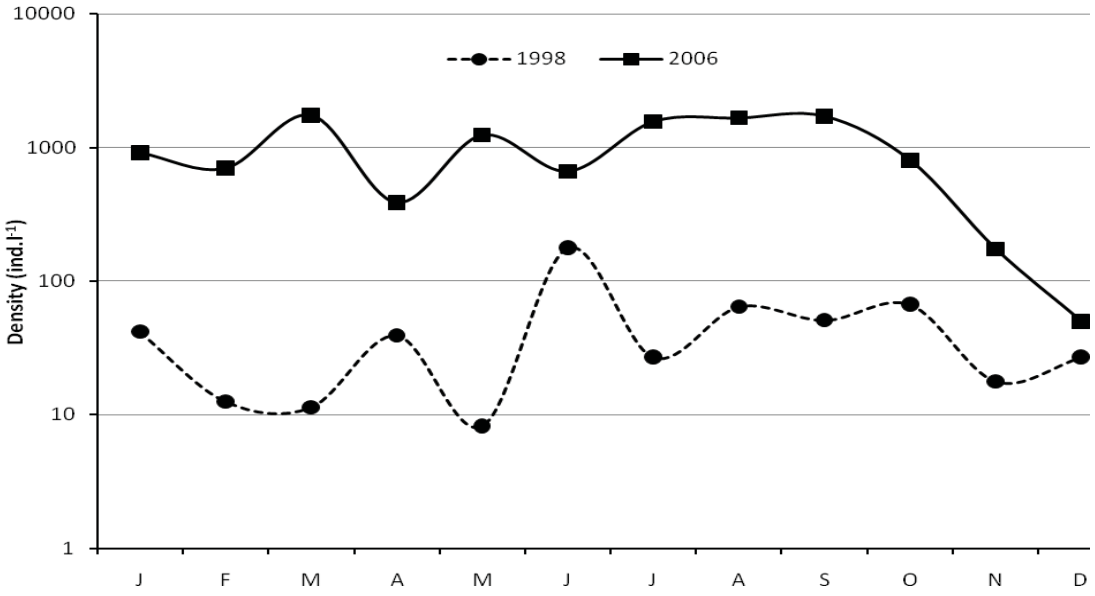

Figure 2. Comparison of monthly mean densities of rotifers in 1998 and 2006.
Figura 2. Comparație a densității medii lunare a rotiferelor în 1998 şi 2006

With their ability to change metabolism rapidly in response to environmental changes, monogonant rotifers can be found in eutrophic systems in high densities (RUTNER-KOLISKO, 1974; TELESH, 1999), individual numbers per liter reaching at times thousands (RUTNER-KOLISKO, 1974). Our findings are in conformity with the generalization mentioned herewith.

In 2006, a relatively higher increase in densities of taxa characteristic to eutrophic waters could also be detected. One of these species, *Pompholyx sulcata*, is reported to be found always in low quantities in zooplankton (RUTNER-KOLISKO, 1974). However, this species was found among the most dominant taxa with 1,104 ind.l^{-1} in May 2006.

Also the number of planktonic rotifer species increases together with to the eutrophication process (GOLDMAN & HORNE, 1983; HARPER, 1992). However, in our study a significant decline in medium term (8 years) in the species numbers contradicts this general statement.

As the plant diversity promotes ecological niche diversification for rotifers, rotifer species richness is directly related to plant density (BIELAŃSKA-GRAJNER & GRUSZKA, 2008). The decrease of submerged plant coverage detected during 2006 surveys, probably linked with lower transparency values (Table 1), should be among the major factors lying behind the decrease of species richness among rotifers.

Among determined species in 1998, marked abundance values of meso-eutrophic taxa *Brachionus* spp. and *Keratella quadrata* were measured. These taxa have disappeared thoroughly from the fauna in 2006. In contrast, *Keratella cochlearis*, *Trichocerca similis*, *T. pusilla,* and *Pompholyx sulcata,* which are typical of eutrophic waters (RADWAN, 1976; RUTNER-KOLISKO, 1974) become more abundant in 2006. These findings show that the increase of trophic level in the 8 year period resulted in significant changes in species composition among rotifers.

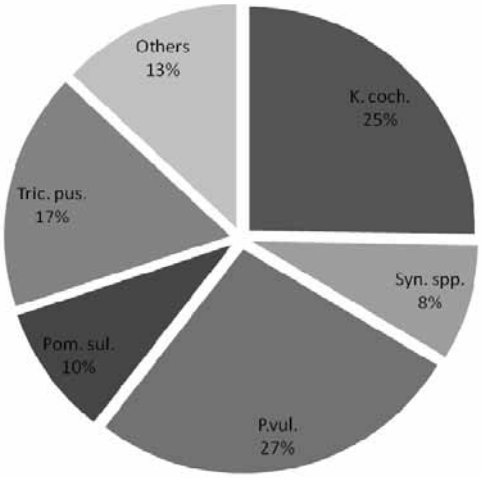

Figure 3. Distribution of Rotifera species in 2006. / Figura 3. Distribuția speciilor de rotifere în 2006.

CONCLUSIONS

Although legally protected, Kovada Lake is subject to nutrient load and organic pollution from agricultural and domestic sources. As understood from the water quality parameters and observations on the flora and fauna, the eutrophication rate has increased especially in the last decades and may reach a critical stage under the current conditions. The cultural eutrophication process, as indicated in this study, affects fauna to considerable extend. Increasing turbidity levels suppress the development of submerged plants, providing ecological niches for the zooplankton.

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Gülle İskender, Yildirim Mehmet Zeki
Mehmet Akif Ersoy University, 15100 Burdur-Turkey
E-mail: igulle@mehmetakif.edu.tr

Ertan Ö. Osman
Süleyman Demirel University. Eğirdir Fisheries Faculty
32500 Isparta-Turkey

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