African Journal of Biotechnology Vol. 8 (21), pp. 5814-5818, 2 November, 2009
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2009 Academic Journals

Full Length Research Paper

Zooplankton abundance in the River Kars, Northeast Turkey: Impact of environmental variables

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Accepted 2 October, 2009

The zooplankton of the River Kars was studied from May to October 2005 at five sampling stations. Thirty different zooplankton taxa were recorded, consisting of one copepod, four cladocera and twenty-five rotifers. The highest zooplankton densities were recorded in July and the lowest in October. Water temperature and nutrients were the main environmental factors which affected zooplankton abundance in the river.

Key words: River Kars, zooplankton, running water, environmental factors.

INTRODUCTION

Although some data are available on zooplankton composition and seasonal dynamics in rivers (Klimowicz, 1981; Saunders and Lewis, 1988; Pace et al., 1991; Van Dijk and Van Zanten, 1995; Chessman, 1985; Petr et al., 2004; Domitrovic et al., 2007), they have received little attention compared with lake zooplankton.

Turkish data on zooplankton communities also concentrate more on lakes than rivers. This study therefore describes the seasonal abundance of zooplankton in the River Kars. The effects of physico-chemical parameters on the plankton community were also monitored.

MATERIALS AND METHODS

The Kars river is 93 km long and its springs are situated in mountains near the town of Sarıkamıs, in North-eastern Turkey. The river units to the River Aras via the Arpacay creek and then discharges into the Arpacay Dam. Base on previous records from State Hydrolic Work Department mean current speed of the river is 0.468 m/sn. On the other hand during the spring season (April-May) current speed of the river further increases (about two fold) due to the flood casued by precipitation and melting snow. The river is contaminated with urban, rural and industrial wastes.

Samples were collected monthly from May to October at five stations, from a bridge in the centre of the river, scattered along the river (Figure 1). Sampling during the winter could not be carried out because of severe weather conditions. At each sampling station, temperature, dissolved oxygen and pH were measured *in situ* with commercial meters. Water samples were also collected for analysis of Soluble Reactive Phosphorus (SRP), Total Phosphate (TP), ammonium-nitrogen and nitrate-nitrogen, in accordance with Mackereth and colleagues (1978). Zooplankton samples were taken with 55 µm mesh-size plankton nets from the surface and samples were preserved in 4% formalin solution. All zooplankton samples were identifed and counted under a stereo microscope (Bottrell et al., 1976) Statistical analyses have been performed with SPSS 16.0.

RESULTS

A total of thirty zooplankton taxa were identified in the River Kars (Table 1). In general, the zooplankton population was very low. Densities of zooplankton ranged between 23 and 1028 organism m^{-3} (Figure 2). Rotifers were dominant from June to August, while the dominant group was copepods in May and September. On the other hand, only rotifers were determined in October.

In general, the River Kars had enough nutrients for zooplankton growth during the study period. Both phosphate and nitrogen levels increased from May to August (Table 2). pH, temperature and dissolved oxygen ranged between 7.6 and 8.0, 9.6 and 21.6°C, and 5.9 and 7.4 mg/L^{-1} respectively. On the other hand, chl *a* level changed from 0.0025 to 0.0059 mg/L^{-1}.

The influence of seven environmental variables and chlorophyll *a* on the abundance of zooplankton groups in the river were assessed using Principal Component Ana-

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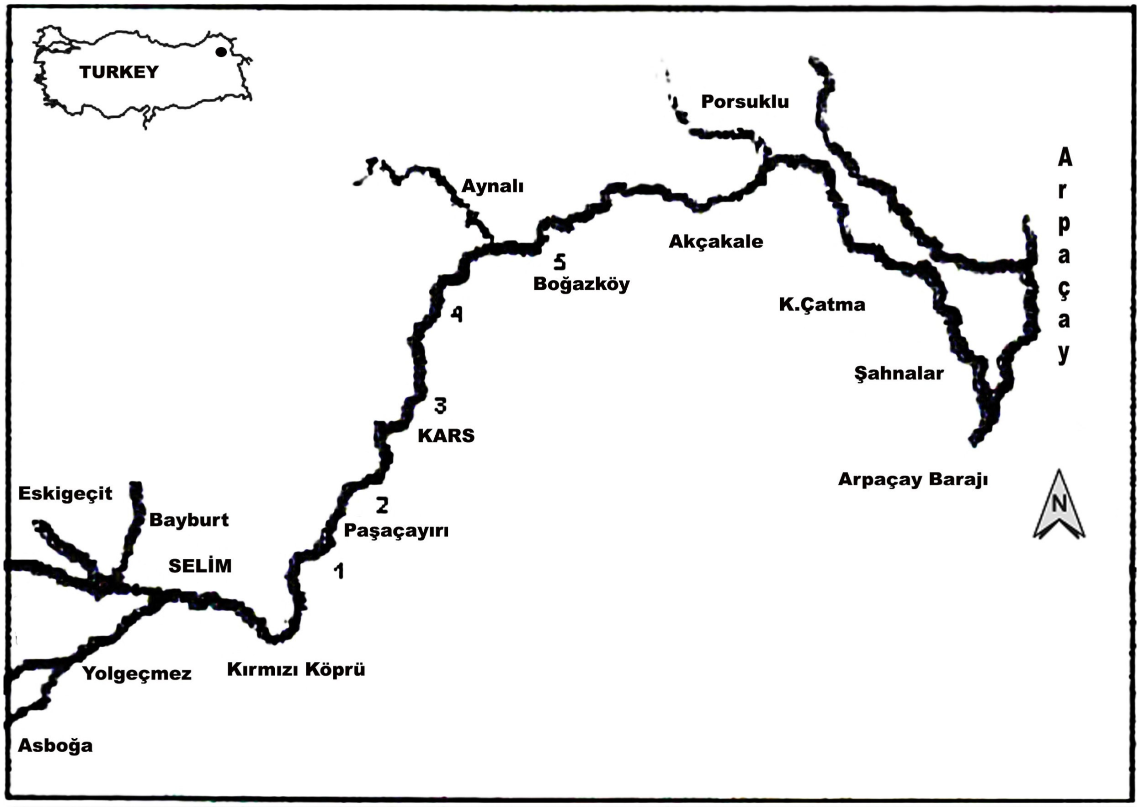

Figure 1. Sampling stations in River Kars.

Table 1. List of zooplankton species indentified during the study.

Copepoda	Rotifera
Cycylops sp.	*Encentrum putorius*
Cladocera	*Encentrum uncinatum*
Alona guttata	*Euchlanis incisa*
Alona rectangula	*Lecane bulla*
Leydigia leydigi	*Lecane closterocerca*
Macrothrix laticornis	*Lecane furcata*
Rotifera	*Lecane hamata*
Brachionus calyciflorus	*Lecane luna*
Cephalodella forficula	*Lecane lunaris*
Cephalodella gibba	*Lecane stenroosi*
Cephalodella ventripes	*Lepadella biloba*
Colurella adriatica	*Lepadella patella*
Colurella colurus	*Lepadella quadricarinata*
Colurella obtusa	*Pleurotrocha petromycon*
Coluralla uncinata	*Polyartha dolichoptera*
Dicranophorus grandis	*Rotaria neptunia*

lysis (PCA). PCA exracted two main factors that explained 99% of the total variance at the river for zooplankton. The first factorial axis (PC1) strongly associated with chlorophyll *a* while the second factorial axis (PC2) closely related with DO (Figure 3).

DISCUSSION

Numerous zooplankton species, the majority of them benthic, were determined in the River Kars, as in other rivers (Krzeczkowska-Woloszyn, 1985; Saunders and Lewis, 1988; Vasquez and Rey, 1989; Van Dijk and Van Zanten, 1995). Seasonal variation in the River Kars also exhibited similarities with other rivers where the zooplankton population is low in winter and high in summer (Pourrıot et al., 1982; Saunders and Lewis 1988; Van Dijk and Van Zanten, 1995).

In general, nutrient levels in the River Kars increased in the summer season, from May to September, owing to the increasing amount of waste discharged into the river from rural, urban and industrial sites located alongside it. Chl *a* level increased with the increasing nutrients, then changed just a little and finally decreased, probably for seasonal reasons (e.g. temperature). In contrast to lakes, notable charecteristic features of the structure and grazing function of the river zooplankton community is that to be absence or low density of the large planktonic crustaceans such as Daphnia (Kobayashi, 1998). There-

Table 2. Average value of physico-chemical variables and chl *a* concentration with ± SD in river water determined during the study.

Month	SRP (μgL^{-1})	TP (μgL^{-1})	NH_4-N (μgL^{-1})	NO_3-N (mgL^{-1})	pH	Temp. (°C)	DO (mgL^{-1})	Chl *a* (mgL^{-1})
May	65.8 ± 5.3	79.8 ±6.9	29.1 ± 7.9	0.44 ±0.04	7.6 ±0.1	19.6 ± 0.5	7.5 ± 0.2	0.0035 ± 0.001
June	100.2 ± 14.2	130.7 ±32.5	63.7 ± 6.8	0.31± 0.08	7.8 ± 0.08	21.6 ± 0.5	5.9 ± 0.5	0.0059 ± .001
July	147.1 ± 6.6	234.3 ±13.8	57.4 ± 10.6	0.38 ± 0.07	7.9 ± 0.05	20.8 ± 0.7	6.6 ± 0.1	0.0047 ± 0.001
August	93.4 ± 12.7	158.8 ±25.5	32.6 ± 5.5	0.42 ± 0.07	8.0 ± 0.07	18.6 ± 0.5	6.1 ± 0.1	0.0044 ± 0.001
September	49.1 ± 10.4	58.2 ±11.7	32.7 ± 7.4	0.14 ± 0.03	7.6 ± 0.10	14.6 ± 0.5	6.4 ± 0.2	0.0058 ± 0.002
October	49.2 ± 7.3	63.3 ±6.7	55.3 ± 17.4	0.27 ± 0.06	7.8 ± 0.15	9.6 ± 0.8	7.0 ± 0.2	0.0025 ± 0.0004

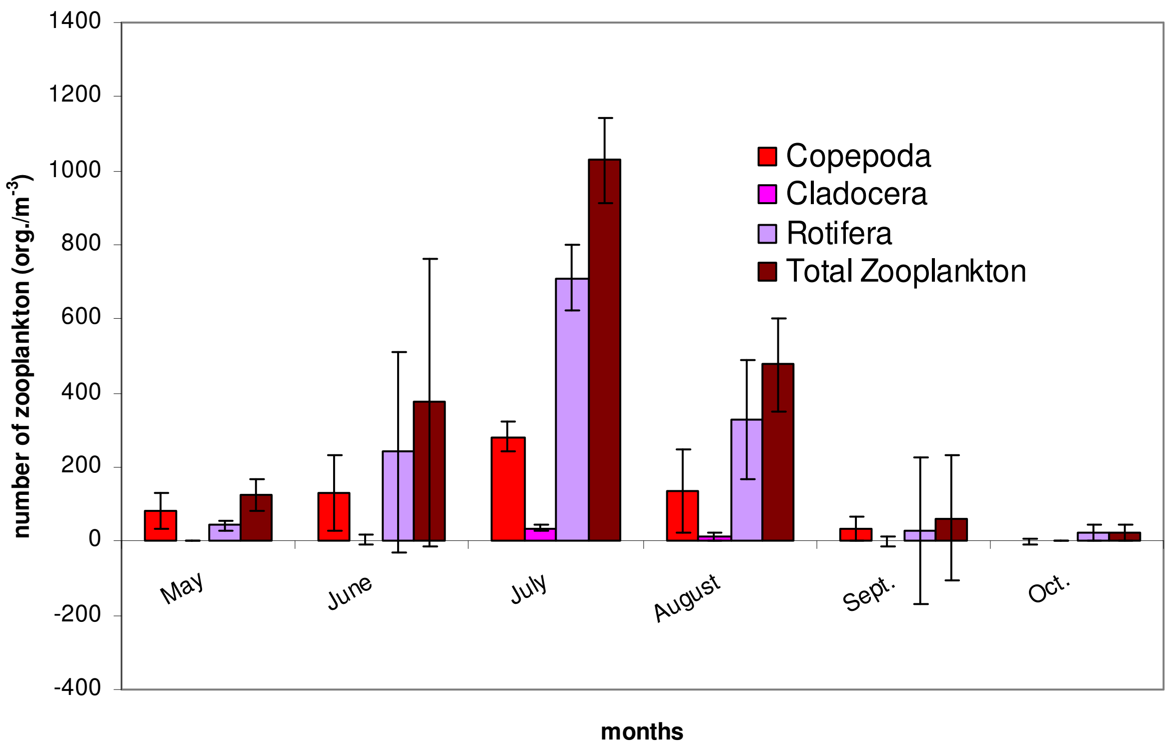

Figure 2. Avarage density of zooplankton groups (org./m^{-3}) determined in river Kars during the study.

fore the zooplankton grazing model is based on micro-zooplankton in the river. This phenomenon is also true for the River Kars. On the other hand since the majority of the zooplankton species were found to be benthic in this study, it seems that zooplankton feeding effect on phyto-plankton growth is insignificant.

Furthermore total zooplankton and zooplankton groups produced negative scores with chlorophyll *a* in this study. On the other hand total zooplankton, rotifer, copepod and cladocera had positive scores with SRP, TP, NO_3-N, NH_4-N, pH, DO and temperature in various degree.

Increasing nutrient levels also increased zooplankton abundance. Total zooplankton abundance significantly correlated with SRP, TP, NO_3-N, NH_4-N, and temperature ($p = 0.000$, $p = 0.000$, $p = 0.015$, $p = 0.043$ and $p = 0.000$ respectively from 1-tailed analysis) but correlation was not significant among total zooplankton, DO, pH and chlorophyll *a*. Although all three zooplankton groups, rotifer, copepod and cladocera, very significantly correlated with SRP and TP ($p = 0.000$), degree of correlation vary for temperature ($p = 0.001$, $p = 0.000$ and $p = 0.022$ respectively) , NO_3-N ($p = 0.018$, $p = 0.034$ and $p = 0.101$ respectively) and NH_4-N ($p = 0.049$, $p = 0,071$ and $p = 0,132$ respectively) in zooplankton groups. Similar results have been found in other studies of rotifers (Pontin, 1978; Sladecek, 1983) and cyclopoid copepods (Gliwiz, 1969).

However, some studies suggest that copepods and cladocera are negatively related to nutrient levels and rotifers are positively related (Zarfdjian et al., 2000). In this study, the majority of the zooplankton comprised rotifers and only *Cyclops* sp. was determined as a copepods. Total zooplankton was therefore found to increase with eutrophication. The rotifer assemblage dominated soon after the flood in River Kars as indicated Russell

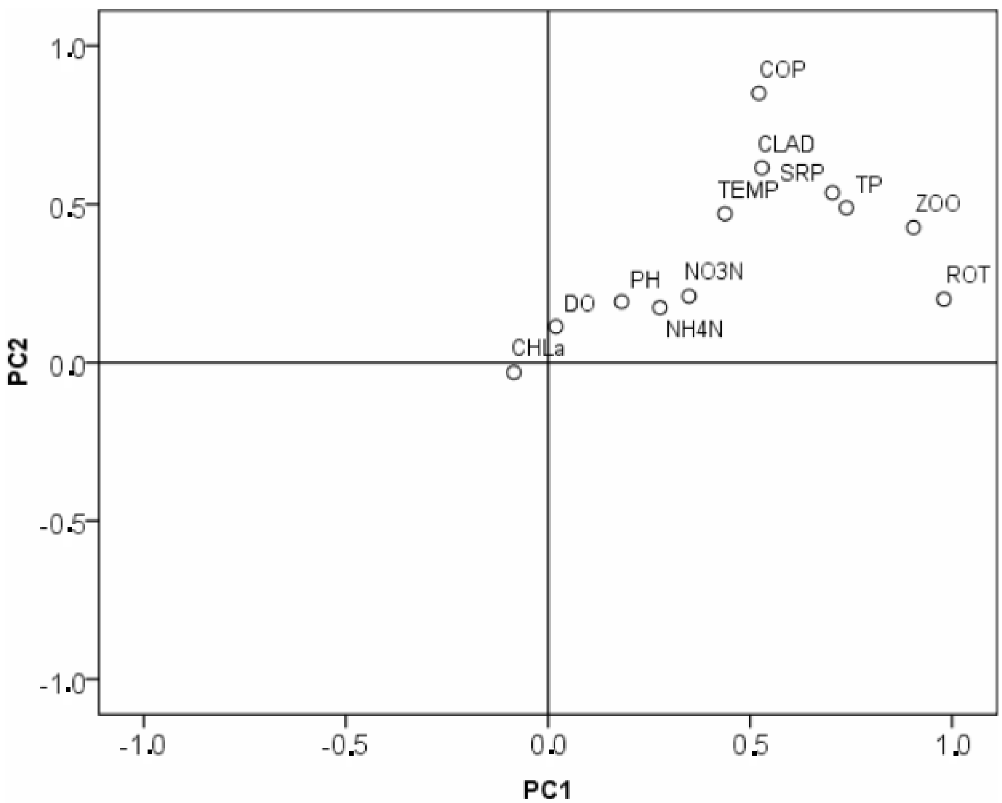

Figure 3. Principal Component Analysis (PCA) of physico-chemical variables and main zooplankton groups. Abbreviations: CHLa; chlorophyll *a*, DO; dissolved oxygen, NH_4N; ammonia nitrogen, NO_3N; nitrate nitrogen, TP; total phosphate, SRP; solouble reactive phosphorus, TEMP; tempareture, ROT; rotifer, CLAD; cladophora, COP; copepod, ZOO; total zooplankton.

and colleagues in Australia rivers (2006).

Furthermore, Thorp and Mantovani (2005) pointed out that since the rotifers may derive some advantage from river turbidity over their food competitors and predators, which are more sensitive to disturbed sediments, rotifers are dominant in turbid rivers while microcrustaceans are less. On the other hand, nitrogen levels did not affect the Cladoceran number, which appeared to change owing to seasonal factors e.g. temperature. Similarly Zarfdjian and colleagues (2000) are found possitive relation between Cladoceran and pH in River Aliakmon. Cladoceran can be an important food source for planktivorous fish and other zooplanktonic predators, when they abundant and therefore perform a key role in production of organic matter (Marazzo and Valentin, 2004). Although there is no study on the fish density in the River Kars, it is known that the fish population increases from March to June in the Eastern part of Turkey (Ozdemir, 1982). Fish predation could therefore be another reason for the small numbers of Cladocera found. Generally, Rotifers were the dominant zooplankton in the River Kars, just as they predominate in other rivers (Klımowicz, 1981; Pourriot et al., 1982; Saunders and Lewis, 1988; Van Dijk and Van Zanten, 1995), because of their short generation time and high reproductive rate (Allan, 1976).

In conclusion, rotifers were the dominant zooplankton group most of the study period in River Kars. Since there is lack of the information about zooplankton diversity and abundance in Turkish river systems, there was no opportunity to make any comparison. Therefore, more studies are needed to understand the structures and ecology of the zooplankton community in both River Kars and the other Turkish river systems.

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