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A Survey on Some Physico-Chemical Parameters and Zooplankton Structure in Karaman Stream, Antalya, Turkey

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Abstract: This survey was carried out to determine some physico-chemical parameters and zooplankton structure in Karaman stream located in Southwestern Turkey. Some physico-chemical parameters and zooplankton structure in Karaman stream were assessed between 9 June 2007 and 9 December 2007. Water and zooplankton samples were collected from 4 different stations in Karaman stream. During the period of investigation 37 species of zooplanktons representing 3 groups namely Rotifera, Cladocera and Copepoda were determined in Karaman stream. Rotifera included 34 species, Cladocera 2 species and Copepoda 1 species were identified in Karaman stream. Of these, *Macrochaetus subquadratus* (Perty, 1850) belonging to Rotifera was a new record for Turkey. Rotifera were the most dominant group in the zooplankton of Karaman stream in this survey. In the water samples, totally 4 physico-chemical parameters were analyzed. As a result of this research, Karaman stream did not show any significant water pollution problem.

Key words: Physico-chemical parameters, zooplankton, Karaman stream, Antalya, Turkey

INTRODUCTION

Zooplankton are microscopic invertebrate animals that swim or drift in water. They are at the base of the food chain, feeding on microscopic plants and being fed upon by aquatic insects, fish and salamanders. The zooplankton play an important role to the faunal bio-diversity of aquatic ecosystems. Zooplankton are good source of food for fishes which in turn are good sources of food for water birds (Surana *et al*., 2005).

The structure of the zooplankton community is especially influenced by climatic, physical and chemical parameters, biogeographical factors and biotic interactions, therefore, some species could be found in a wide range of environmental conditions, while others are limited by many physical and chemical factors including pollution. Individuals of the zooplankton community are widely utilized as bio-indicators of environmental pollution because they are easy to collect to identify and as a whole community, they respond quickly to environmental stresses (Gannon and Sternberger, 1978; Hellawell, 1986; Dumont, 1999; Neves *et al*., 2003; Utz and Bohrer-Morel, 2008).

Investigations on the structure of the zooplanktonic community and abundance of organisms coupled with analyses of chemical and physical parameters of the water are important to obtain basic knowledge on the species diversity of a given water body as well as its underlying dynamics. The majority of studies about the composition of zooplankton communities has focused on rotifers, cladocerans and copepods (Beaver and Crisman, 1982; Neves *et al*., 2003; Utz and Bohrer-Morel, 2008). In freshwater ecosystems, 3 groups of zooplankton, namely Rotifera, Cladocera and Copepoda have been reported (Berzins and Pejler, 1987).

Many studies have been performed on zooplanktonic organisms of lentic ecosystems in Turkey, such as those by Geldiay and Tareen (1972), Tokat (1972, 1976), Dumont and De Ridder (1987), Ustaoglu (1986, 1993), Gunduz (1987, 1991), Ortak and Kirgiz (1988), Ustaoglu and Balik (1990), Segers *et al.* (1992), Emir (1994), Emir and Demirsoy (1996), Altindag and Sozen (1996), Altindag (1997, 1999, 2000), Altindag and Yigit (2002, 2004), Bozkurt and Goksu (2000), Guher (1999, 2002), Bekleyen (2001, 2003), Ustaoglu *et al.* (2001, 2003), Saler (2004), Yigit and Altindag (2005), Yalim and Ciplak (2005), Bozkurt (2006), Turkmen *et al.* (2006), Kaya and Altindag (2007), Yildiz *et al.* (2007), Bozkurt and Sagat (2008) and Bekleyen and Tas (2008). These studies are focused particularly on lakes and dams.

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Only a few studies on zooplanktonic organisms of lotic ecosystems in Turkey was conducted by Ustaoglu *et al.* (1996, 1997) in Gumuldur stream, Balik *et al.* (1999) in Northern Aegean region's rivers, Saler *et al.* (2000) in Komurhan region of Firat river, Saler and Sen (2001) in Zikkim stream, Bozkurt *et al.* (2002) in Asi river, Goksu *et al.* (2005) in Asi river, Akbulut and Yildiz (2005) in Euprathes river Basin. These studies are focused particularly on rivers and streams. There was a few studies on zooplanktonic organisms of lotic ecosystems in Turkey. Therefore, the zooplanktonic organisms of Karaman stream have not been studied before yet.

Karaman stream is situated about 30 km Northwest of Antalya city centre. Antalya is a city on the Mediterranean coast of southwestern Turkey. Antalya is located in southwestern part of the Mediterranean region of Turkey. Situated on a cliff over the Mediterranean, Antalya is surrounded by mountains. Antalya has a Mediterranean climate. Since, the area is closed to the cold Northerly winds, it is characterized by the typical Mediterranean climate with hot, dry summers and moderately warm and rainy winters. The humidity is a little bit high, about 64% and the average water temperature is 21.5°C. The sources of Karaman stream are Beydag, Goldag and Gulluk mountains, which is located to the Northweast of Antalya. Karaman stream is a important branch of the Boga river (Anonymous, 2004).

This survey was carried out to determine some physico-chemical parameters and zooplankton structure in Karaman stream.

MATERIALS AND METHODS

Karaman stream is located in Southwestern Turkey. This research was carried out between 09 June 2007 and 09 December 2007 in Karaman stream. The samples were collected at 4 different stations in Karaman stream. The location of Karaman stream and the sampling stations are shown in Fig. 1. The zooplankton samples were collected by use of a plankton net (Hydrobios Kiel, 25 cm diameter and 55 μm mesh size) from each stations. The zooplankton samples were fixed with 4% formaldehyde solution immediately after collection in 300 mL plastic bottles. The zooplankton species were identified according to Edmondson (1959), Kolisko (1974), Koste (1978), Nogrady *et al.* (1993), Nogrady and Pourriot (1995), Segers (1995), De Smet (1996) and Smirnov (1996). Besides, hierarchical cluster analysis (Bray-Curtis similarity index; group average) was calculated between the stations for zooplankton species in Karaman stream. For the statistical cluster analysis, SPSS for windows computer programme was used in this research.

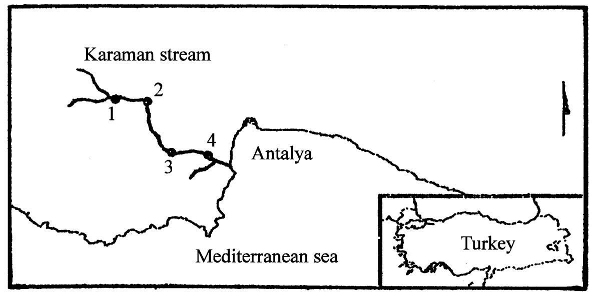

Fig. 1: Karaman stream and stations

Some physico-chemical parameters of Karaman stream were determined during the sampling period. Water temperature, electrical conductivity, pH and dissolved oxygen parameters were measured in Karaman stream. Of these, water temperature and dissolved oxygen were measured with a YSI 51 B model oxygen meter, electrical conductivity was measured with a WTW LF 92 type conductivimeter, pH was measured with a WTW 340-A/SET-1 model pH meter.

RESULTS AND DISCUSSION

The some physico-chemical parameters were measured; water temperature, electrical conductivity, pH and dissolved oxygen in Karaman stream. The mean values of some physico-chemical parameters determined in Karaman stream according to stations are given in Table 1. The mean values of water temperature were ranged between 16.5 and 17.3°C in Karaman stream. There was no very significant difference between in water temperature mean values in Karaman stream. Temperature is basically important for its affects on certain chemical and biological activities in the organism attributing in aquatic life. The water temperature and air temperature were found to go more or less hand in hand (Singhal *et al.*, 1986).

The mean values of electrical conductivity were ranged between 690 and 750 μS cm^{-1} in Karaman stream. Electrical conductivity is the measure of water's ability to conduct an electrical current through dissolved ions. These ions include sodium, calcium, potassium, magnesium, iron, aluminum, chloride, sulfate, carbonate and bicarbonate. The conductivity increased with the increase in total dissolved solids and water temperature (Entz, 1973).

In this study period, the mean values of pH were ranged between 8.18 and 8.21 in Karaman stream. According to the mean values of pH was found to be fairly alkaline at 4 stations in Karaman stream. The pH is the scale of intensity of acidity and alkalinity of water and

Table 1: Mean values of physico-chemical parameters in Karaman stream

	Stations			
Physico-chemical parameters	1	2	3	4
Water temperature (°C)	16.9	17	16.5	17.3
Electrical conductivity (μS cm^{-1})	710	720	690	750
pH	8.21	8.21	8.18	8.20
Dissolved oxygen (mg L^{-1})	8.78	8.19	8.85	8.52

measures the concentration of hydrogen ions. Most of the biological processes and biochemical reactions are pH dependent (Minns, 1989). According to the EPA (1980), accepted water quality criteria indicate a pH of <6.5 units may be harmful to many species of fish. Therefore, the pH range of 6.5-9.0 units would be suitable for the protection of aquatic habitats. According to the EPA (1980), the mean values of pH were normal in Karaman stream.

The mean values of dissolved oxygen were ranged between 8.19 and 8.85 mg L^{-1} in Karaman stream. Throughout the survey period, no important difference was found in dissolved oxygen values between 4 station. Dissolved oxygen is one of the important parameter in water quality assessment and reflects the biological and physical processes prevailing in the water. In freshwater ecosystems, the minimum dissolved oxygen may not be <5.0 mg L^{-1} for aquatic (Egemen and Sunlu, 1999). The mean values of dissolved oxygen were normal in Karaman stream for aquatic life. According to classification continental inland water sources of the water pollution control regulation in Turkey, if dissolved oxygen is 8 m L^{-1}, the water is I class; if it is 6 mg L^{-1}, the water is II class; if it is 3 mg L^{-1}, the water is III class and if dissolved oxygen is <3 mg L^{-1}, the water is IV class (Anonymous, 1988). According to those limits, Karaman stream could be categorized as I class. It is obvious that Karaman stream has a high water quality standard or I class. Thus, it can be said that Karaman stream water can be used not only for drinking purpose by disinfecting it, but also for recreational aims, rainbow trout culture, animal production and other aims.

The last checklist is prepared by Ustaoglu (2004), which is based on compilation of previous zooplankton studies carried out at Turkish inland waters. After all studies referred above, 229 Rotifera species, 92 Cladocera species and 106 Copepoda species have been listed from Turkish inland waters (Ustaoglu, 2004).

In recent years, studies with large contribution to Rotifera fauna of Turkey has been made (Altindag *et al.*, 2005; Akbulut and Yildiz, 2005; Erdogan and Guher, 2005; Ustaoglu *et al.*, 2005; Kaya *et al.*, 2006; Akbulut and Kaya, 2007; Kaya *et al.*, 2008; Kaya and Altindag, 2007a, b; 2009). Thus, from Turkey recorded the number of Rotifera species was increased 281.

During the period of this survey, 37 species of zooplankton representing 3 groups namely Rotifera, Cladocera and Copepoda were determined in Karaman stream. Structure of zooplankton groups in Karaman stream are given in the Table 2. Rotifera included 34 species (*Brachionus angularis*, *Cephalodella gibba*, *Cephalodella ventripes*, *Colurella adriatica*, *Colurella colurus*, *Colurella obtusa*, *Euchlanis dilatata*, *Keratella cochlearis*, *Lecane bulla*, *Lecane clostrocerca*, *Lecane flexilis*, *Lecane furcata*, *Lecane hamata*, *Lecane luna*, *Lecane lunaris*, *Lecane punctata*, *Lecane pyriformis*, *Lepadella acuminata*, *Lepadella ehrenbergi*, *Lepadella patella*, *Lepadella quadricarinata*, *Lepadella quinquecostata*, *Lindia tecusa*, *Lindia torulosa*, *Mytilina ventralis*, *Macrochaetus subquadratus*, *Scaridium longicaudum*, *Squatinella rostrum*, *Synchaeta oblonga*, *Trichocerca bidens*, *Trichocerca longiseta*, *Trichocerca weberi*, *Trichotria pocillum* and *Trichotria tetractis*), Cladocera 2 species (*Chydorus sphaericus* and *Alona quadrangularis*) and Copepoda 1 species (*Cyclops* sp.). Of these, *Macrochaetus subquadratus* belonging to Rotifera was identified as a new record for Turkey. *Macrochaetus subquadratus* specimens were collected from station 2 and station 3 in Karaman stream (Table 2).

Zooplankton of Karaman stream consist mainly of Cladocera, Copepoda and Rotifera groups. In all, 37 zooplankton species, Rotifera were found dominant taxonomic group with 34 species (91.89%), followed by with 2 species (5.41%) Cladocera and Copepoda with 1 species (2.70%) in Karaman stream. Rotifers are one of the basic groups of the zooplankton community providing the energy flux of freshwater ecosystems and they inhabit virtually all aquatic habitats. In freshwater ecosystems, rotifers are more abundant than other zooplankton groups; therefore, they account for a major portion of the food chain. An increase in Rotifers, Cladocerans and Copepods populations may affect fish populations (Berzins and Pejler, 1987; Emir and Demirsoy, 1996; Barrabin, 2000; Saler, 2004).

Rotifera were found to be more sensitive to environmental changes as compared to Cladocera and Copepoda, are known to be characteristic indicators of water quality (Gannon and Stemberger, 1978). Among the zooplankton community, rotifer abundance appears to be linked to trophic conditions of the environment. De Paggi (1976) reported that rotifers represented 99.4% of the zooplankton community in an eutrophic water body. Calanoid copepods are generally abundant in oligotrophic environments, while cyclopoids and cladocerans dominate in eutrophic waters (Wetzel, 2001; Utz and Bohrer-Morel, 2008).

Table 2: Structure of zooplankton groups in the Karaman stream

Zooplankton groups and species	Stations 1	2	3	4
Rotifera				
Brachionus angularis (Gosse, 1851)	-	-	+	-
Cephalodella gibba (Ehrenberg, 1830)	+	+	+	-
Cephalodella ventripes (Dixon-Nuttall, 1901)	-	-	-	+
Colurella adriatica (Ehrenberg, 1831)	-	-	+	-
Colurella colurus (Ehrenberg, 1830)	+	-	-	-
Colurella obtusa (Gosse, 1886)	+	+	-	+
Euchlanis dilatata (Ehrenberg, 1832)	-	+	-	+
Keratella cochlearis (Gosse, 1851)	-	+	-	
Lecane bulla (Gosse, 1851)	+	-	-	-
Lecane clostrocerca (Schmarda, 1859)	+	-	+	-
Lecane flexilis (Gosse, 1886)	-	+	+	+
Lecane furcata (Murray, 1913)	-	+	-	-
Lecane hamata (Stokes, 1896)	-	+	-	-
Lecane luna (O.F. Muller, 1776)	-	+	-	-
Lecane lunaris (Ehrenberg, 1832)	-	-	+	-
Lecane punctata (Murray, 1913)	-	+	-	-
Lecane pyriformis (Daday, 1905)	-	+	-	-
Lepadella acuminata (Ehrenberg, 1834)	-	-	+	-
Lepadella ehrenbergi (Perty, 1850)	-	-	+	-
Lepadella patella (O.F. Muller, 1773)		+	-	+
Lepadella quadricarinata (Stenroos, 1898)	+	-	+	+
Lepadella quinquecostata (Lucks, 1912)	-	+	-	-
Lindia tecusa (Harring and Myers, 1922)	+	-	-	-
Lindia torulosa (Dujardin, 1841)	-	-	+	-
Mytilina ventralis (Ehrenberg, 1830)	-	-	-	+
Macrochaetus subquadratus (Perty, 1850)	-	+	+	-
Scaridium longicaudum (O.F. Muller, 1786)	+	-	-	-
Squatinella rostrum (Schmarda, 1846)	+	-	-	-
Synchaeta oblonga (Ehrenberg, 1831)	+	-	-	+
Trichocerca bidens (Lucks, 1912)	-	-	-	+
Trichocerca longiseta (Schrank, 1802)	-	-	-	+
Trichocerca weberi (Jennings, 1903)	-	+	-	-
Trichotria pocillum (O.F. Muller, 1776)	-	-	+	-
Trichotria tetractis (Ehrenberg, 1830)	-	-	+	+
Cladocera				
Chydorus sphaericus (O.F. Muller, 1785)	-	-	-	+
Alona quadrangularis (O.F. Muller, 1785)	+	-	+	-
Copepoda				
Cyclops sp. (O.F. Muler, 1758)	+	-	+	+

Distribution of species according to the genus are done it appears that Lecane (9 species) is the richest fallowed by Lepadella (5 species), Colurella (3 species) and Trichocerca (3 species) in survey area. Member of these 4 genus are commonly found in the zooplankton of freshwater are able to adapt to various physical and chemical environments (Koste, 1978; Erdogan and Guher, 2005). Among the species determined, *Cephalodella gibba, Colurella obtusa, Lecane flexilis, Lepadella quadricarinata* and *Cyclops* sp. are dominantly found in Karaman stream (Table 2).

Ramdani *et al.* (2001) reported that the cluster analysis produced a good visual of the comparison based on zooplankton species presence or absence. The cluster analysis of zooplankton species determined at stations in Karaman stream are given in Fig. 2. According to the results of the hierarchical cluster analysis; 3 stations, namely station 1, 3 and 4 shared the same group, where the highest similarity was observed between the station 1 and station 4 with 68% in Karaman stream.

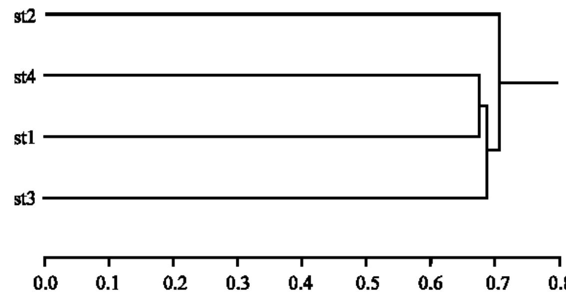

Fig. 2: Cluster analysis of zooplankton species at between stations

CONCLUSION

Karaman stream can be characterized quite rich as regard to in zooplankton structure. The above is taken into consideration the physico-chemical results, Karaman stream water quality was found to be suitable for aquatic life. As a result of this survey, Karaman stream was not show any significant water pollution problem. This survey can be useful contributions to zooplankton fauna of Turkey and be a resource for detailed studies in future on Karaman stream. A continuous monitoring programme of the Karaman stream will provide rather useful knowledge for environmental management.

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