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Zooplankton Fauna of Yeşilırmak (between Tokat and Blacksea), Hasan Uğurlu and Suat Uğurlu Dam Lakes

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Abstract

A total of 42 taxa consisting of 23 Rotifera, 11 Cladocera, and 8 Copepoda were identified during the study performed in the lower basin of Yeşilırmak River containing two dam lakes (Suat and Hasan Uğurlu Dam Lakes). The most abundant species were *Keratella cochlearis*, *Polyarthra dolichoptera* of Rotifera; *Bosmina longirostris*, *Ceriodaphnia pulchella* of Cladocera; *Eudiaptomus gracilis* and *Acanthocyclops robustus* of Copepoda. Zoopankton abundance (number per m^3) was high in Hasan Uğurlu and Suat Uğurlu Dam Lakes in during July, 2009

Keywords: Zooplankton, Inland water, Suat Uğurlu, Hasan Uğurlu, Yeşilırmak River.

Yeşilırmak (Tokat ve Karadeniz arası), Hasan Uğurlu ve Suat Uğurlu Baraj Gölleri Zooplankton Faunası

Özet

Yeşilırmak (Tokat İli-Karadeniz arası) ve Yeşilırmak üzerinde bulunan Hasan Uğurlu ve Suat Uğurlu Baraj Gölleri'nde yapılan çalışmada, Rotifera'dan 23, Kladosera'dan 11 ve Kopepoda'dan 8 olmak üzere toplam 42 takson tespit edilmiştir. En çok bulunan türler Rotifera'dan *Keratella cochlearis*, *Polyarthra dolichoptera*; Kladosera'dan *Bosmina longirostris*, *Ceriodaphnia pulchella*; Kopepoda'dan *Eudiaptomus gracilis* ve *Acanthocyclops robustus* olduğu belirlenmiştir. Kantitatif bakımdan ise zooplankton en çok Temmuz 2009'da Hasan Uğurlu ve Suat Uğurlu Baraj Göllerinde olduğu tespit edilmiştir.

Anahtar Kelimeler: Zooplankton, iç sular, Suat Uğurlu, Hasan Uğurlu, Yeşilırmak.

Introduction

Although zooplanktonic organisms which live in stagnant waters attracts attention of Turkish scientists (Bekleyen, 2003; Kaya and Altındağ, 2007; Apaydın Yağcı and Ustaoğlu, 2012 e.g.), it can't be said the same thing for running waters are much ignored. Only few studies are present (Bozkurt, 2004; Bozkurt and Güven, 2010; Kaya *et al*. 2010). In this study, a running water system called Yeşilırmak was surveyed in terms of zooplankton.

Zooplanktonic organisms are important especially for fry nourishment. The abundance of zooplankton is an indicator for eutrophication and pollution levels since the abundance and composition of zooplankton are closely associated with water quality and show increasing and decreasing pattern based on trophic levels of lakes (Canfield and Jones, 1996).

Turkey is a country which is rich in inland water. Aquatic system in Turkey has about one million square kilometer surface area and 60% of this surface area is freshwater, 20% is salt water and remaining percent 20% is brackish water. The lakes constituting the biggest parts of still water show different ecological features of water at different localities and vary in terms of quantitative and qualitative depending on this (Yalım, 2006). Therefore, there is an urgent need for research about freshwater fauna in all regions of Turkey.

Studies on zooplanktonic organisms are important for freshwater ecosystem. According to our best knowledge, there is no study on zooplankton in the waters of Black Sea Region of Turkey, especially in Yeşilırmak system.

Since studies on zooplankton of inland water are important for determination, prediction and evaluation of long-term changes in aquatic ecosystem, this study was performed for determination of structure and abundance of zooplankton both in Yeşilırmak

tributary system and Hasan Uğurlu and Suat Uğurlu Dam Lakes built on the river.

Materials and Methods

This study was performed in the lower basin of Yeşilırmak River. The study area included two dam lakes, Suat and Hasan Uğurlu as well as the river sections below and above the Dam Lakes (Figure 1). Originating at Köse Mountain on the east, Yeşilırmak River continues to flow through Canik Mountain and passes through the Çarşamba Praire by spreading itself there and flows into Black Sea. Yeşilırmak River, 519 km in length, consists of mergering of three main tributaries which are Kelkit, Çekerek and Tozanlı Streams. There are five power plants on the river, which are Kılıçkaya on the Kelkit Streams, Ataköy and Almus on the Tozanlı Stream and Suat and Hasan Uğurlu on the river near the mouth.

Suat Uğurlu Dam Lake is located at latitude of 41º03' N and longitude of 36°40' E, 55 kilometers south of Samsun province, Turkey. It is 60 m above the sea level. The reservoir has a maximum depth of 25 m, a length of 382 m and a surface area of 10 km^2. The maximum inflow (5 10^7 m^3 s^{-1}) to the reservoir occurs in spring and the minimum (25 m^3 s^{-1}) in fall. The reservoir was built in 1982 for irrigation and power generation

Hasan Uğurlu Dam Lake is located at latitude of 40°55' N and longitude of 36°38' E, 25 kilometers south of Samsun province, Turkey. The reservoir is 90 m above the sea level. It has a maximum depth of 54 m, a length of 658 m and a surface area of 23 km^2. The maximum inflow (87 10^9 m^3 s^{-1}) to the reservoir occurs in spring and the minimum (13 10^5 m^3 s^{-1}) in fall. The reservoir was built in 1981 for power generation.

Samples of zooplankton were collected by vertical hauls of a standard net (60 µm mesh size), in April 2008, July 2008, November 2008, February 2008, June 2009 and July 2009, during routine survey cruises in the river section above and below the dam lakes and two dam lakes in 9 sites. Sites 1, 2, and 3 were located on the river section below Suat Uğurlu Dam Lake, sites 4 was in Suat Uğurlu, 5 (Terce Creek) was between two dams and 6,7 were in Hasan Uğurlu Dam Lake and sites 8K and 8T were located on the Kelkit and Tozanlı Stream flowing into Hasan Uğurlu Dam.

The net was hauled vertically from bottom to the surface in the dam lakes and then samples were replaced into glass jar. Water samples of 80 L were taken from the river to determine density of zooplankton and the water samples were filtered in the field using a 60 µm mesh plankton net and were replaced into glass jar as well.

Plankton samples were fixed with 4% buffered formaldehyde and analysed in the laboratory under a stereomicroscope (Olympus CH40) for taxonomic features. Density of specimen was estimated by optical inverted microscopy according to Wetzel (1975). Number of organism in a liter was determined by counting all vertical samples in the dams and

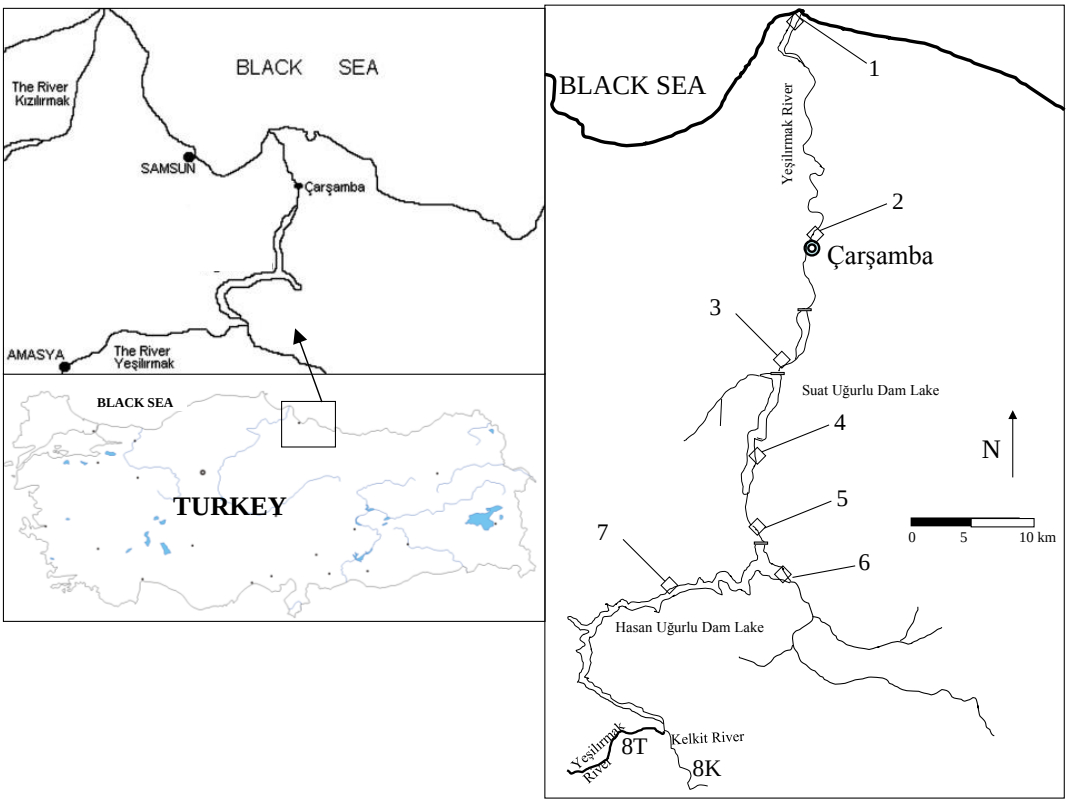

Figure 1. Sampling stations. Suat Uğurlu Dam Lake (4), Terce Creek (5), Hasan Uğurlu Dam Lake (6,7), Tozanlı (8T), Kelkit (8K).

filtered water samples in the river.

The samples are kept at the Plankton Laboratory, Aquaculture and Fisheries Faculty, Mustafa Kemal University. The species were identified with the aid of Edmondson (1959); Borutsky (1964); Scourfield ve Harding (1966); Dussart (1969); Damian-Georgescu (1970); Ruttner-Kolisko (1974); Kiefer (1978); Koste (1978); Stemberger (1979); Segers (1995); Dodson (2002).

Water temperature, dissolved oxygen, salinity and conductivity were measured with an YSI-85 water quality meter. The other parameters (turbidity and pH) were measured with a WTW Photoflex Turb Photometer in the field. All statistical analyses were performed by using MS Excel.

Results

A total of 42 taxa were found in the study area, including 23, 11 and 8 taxa belonging to Rotifera, Cladocera and Copepoda, respectively (Table 1). Brachionidae, Cyclopoidae and Daphniidae belonging to Rotifera, Copepoda, and Cladocera were the richest families represented by 9, 6 and 5 species, respectively.

Spatial variation in number of species was presented in Figure 2**.** Although the number of species of Rotifera and Cladocera were higher in Suat Uğurlu Dam Lake (14 and 10 species, respectively), the highest number species (7 species) belonging to Copepod was obtained at station 3 in river section below Suat Uğurlu Dam Lake. Suat Uğurlu Dam Lake, containing the highest number of species (30 species) was the most species richest station.

Temporal variation in number of species was presented in Figure 3. Number of species belonging to

Table 1. Zooplankton species in the study area

Phyllum : Rotifera Classis : Eurotatoria Subclassis: Monogononta Ordo : Ploimida	Familia: Brachionidae	*Brachionus angularis* Gosse, 1851 *B. calyciflorus* Palas, 1766 *B. quadridentatus* Hermann, 1783 *B. budapestinensis* Daday, 1885 *Keratella cochlearis* (Gosse, 1851) *K. quadrata* (O.F.Müller, 1786) *K. tropica* (Apstein, 1907) *Notholca squamula* (O.F.Müller, 1786) *N. acuminata* (Ehrenberg, 1832)
	Familia: Euchlanidae	*Euchlanis dilatata* Ehrenberg, 1832
	Familia: Mytilinidae	*Lophocharis salpina* (Ehrenberg, 1834)
	Familia: Lepadellidae	*Colurella uncinata* (O.F.Müller, 1773) *Lepadella patella* (O.F.Müller, 1786)
	Familia: Lecanidae	*Lecane (M.) lunaris* (Ehrenberg, 1832) *L. (M.) bulla* (Gosse, 1886)
	Familia: Notommatidae	*Cephalodella gibba* (Ehrenberg, 1838)
	Familia: Trichocercidae	*Trichocerca(D.) similis* (Wierzeski,1893)
	Familia: Synchaetidae	*Synchaeta pectinata* Ehrenberg, 1832 *Polyarthra dolichoptera* Idelson,1925
	Familia: Asplanchnidae	*Asplanchna priodonta* Gosse,1850
	Ordo: Floscullariacea Familia: Testudinellidae	*Testudinella patina* (Hermann,1783) *Pompholyx sulcata* (Hudson, 1885)
	Familia: Filiniidae	*Filinia longiseta* (Ehrenberg,1834)
Phylum :Arthropoda Subphylum :Crustacea Klasis :Branchiopoda Subklasis: Phyllopoda Ordo : Diplostraca Subordo : Cladocera	Familia: Sididae	*Diaphanosoma birgei* Korinek,1981
	Infraordo: Anomopoda Familia: Daphniidae	*Daphnia longispina* O.F.Müller, 1875 *D. galeata* Sars, 1864 *D. cucullata* Sars, 1862 *Simocephalus vetulus* (O.F.Müller, 1776) *Ceriodaphnia pulchella* Sars, 1862
	Familia: Bosminidae	*Bosmina longirostris* (O.F.Müller, 1785)
	Familia: Chydoridae Subfamilia: Chydorinae	*Pleuroxus aduncus* (Jurine, 1820) *Disparalona rostrata* (Koch, 1841) *Chydorus sphaericus* (O.F.Müller, 1776)
	Subfamilia: Aloninae	*Alona quadrangularis* (O.F.Müller, 1785)
Phylum :Arthropoda Subphylum : Crustacea Clasis : Maxillopoda Subclasis :Copepoda Ordo :Calanoidea	Familia: Diaptomidae Subfamilia: Paradiaptominae	*Eudiaptomus gracilis* (G.O. Sars, 1863)
	Ordo: Cyclopoida Familia: Cyclopoidae Subfamilia: Eucyclopinae	*Eucyclops serrulatus* (Fischer, 1851)
	Subfamilia: Cyclopinae	*Cyclops vicinus* Uljanin, 1875 *Acanthocyclops robustus* (G.O.Sars, 1863) *Megacyclops viridis* (Jurine, 1820) *Diacyclops* sp. *Thermocyclops dybowskii* (Lande, 1890)
	Ordo:Harpacticoida Familia: Ameiridae	*Nitocra hibernica* (Brady, 1880)

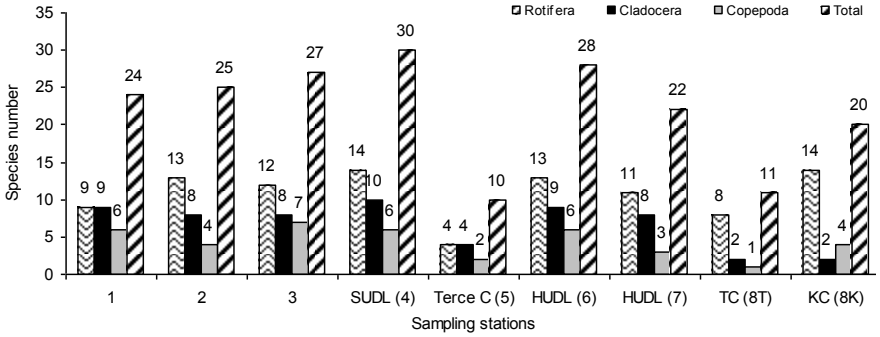

Figure 2. Variation of species in stations (SUDL (4): Suat Uğurlu Dam Lake, Terce C: Terce Creek, HUDL (6,7): Hasan Uğurlu Dam Lake, TC (8T): Tozanlı Creek, KC (8K): Kelkit Creek).

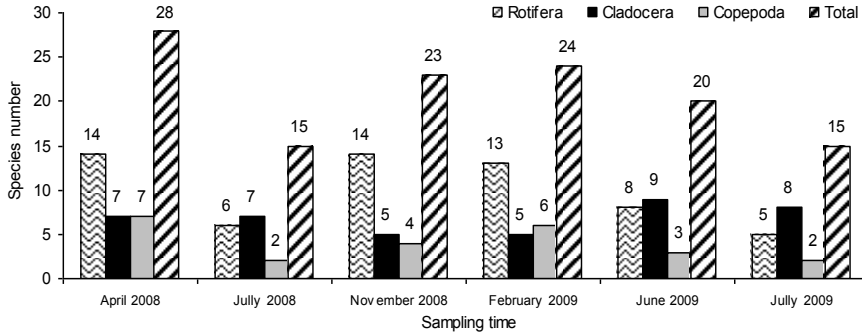

Figure 3. Variation of species on sampling times.

Rotifera (14 species), Cladocera (9 species) and Copepoda (7 species) was highest in April 2008 and November 2008, June 2009 and April 2008, respectively. The total number of species was higher (28 species) in April 2008 compared to the other months.

Species pattern of stations showed different pattern during the study. For example, rotifer *Keratella quadrata* (O. F. Muller, 1786) except for Tozanlı Creek, *Cephalodella gibba* (Ehrenberg, 1830) except for first station, *Filinia longiseta* (Ehrenberg, 1834) except for Tozanlı Creek, and *Pompholyx sulcata* Hudson, 1885 except for seventh station and Tozanlı Creek were found in all other stations, while *Keratella cochlearis* (Gosse, 1851) was found in all stations during the study. The species occurred at only one station during the study were *Testudinella patina* (Hermann, 1783), *Lepadella patella* (Müller, 1773), *Brachionus budapestinensis* Daday, 1885, *Lecane lunaris* (Ehrenberg, 1832) and *Lophocharis salpina* (Ehrenberg, 1834). The most abundant species (ind.m^{-3}) was *K. cochlearis* (33793±6047.88 ind. m^{-3}) in Hasan Uğurlu Dam Lake. *Polyarthra dolichoptera* Idelson, 1925 (18787±2115.81 ind. m^{-3}) and *Synchaeta pectinata* Ehrenberg, 1832 (8490±7.78 ind. m^{-3}) were found the second and third abundant species at station 7 and Suat Uğurlu Dam Lake, respectively. The least abundant species were *Notholca acuminata* (Ehrenberg 1832) (15±4.95 ind. m^{-3}) in Hasan Uğurlu Dam Lake (station 6) and *Colurella uncinata* (Müller, 1773) (15±12.73 ind. m^{-3}) in Tozanlı Creek.

Acanthocyclops robustus (G. O. Sars, 1863) (Copepoda) was found at all stations while *Eudiaptomus gracilis* (G.O. Sars 1863), cladocerans *Daphnia longispina* (O.F. Müller, 1776), *Bosmina longirostris* (O. F. Müller, 1785) (except for Tozanlı Creek) and *Ceriodaphnia pulchella* Sars 1862 (except for Kelkit Creek) were found at 8 stations. *D. galeata* G. O. Sars, 1864 (except for Tozanlı and Kelkit Creek) and *Alona quadrangularis* (O. F. Müller, 1776) (except for Kelkit Creek station 3) were found at seven stations (Table 2).

In this study, the most common species belonging to Cladocera was *Pleuroxus aduncus* (Jurine, 1820) (48825±148.49 ind. m^{-3}) in Hasan Uğurlu Dam Lake. The second abundant species was *Diaphanosoma birgei* Korinek, 1981 (15578±2160.42 ind. m^{-3}) obtained in Hasan Uğurlu Dam Lake and followed by *P. aduncus* (8636±48.08 ind. m^{-3}) and *D. birgei* (6503±28.99 ind. m^{-3}) obtained in station 7 of Hasan Uğurlu Dam Lake, respectivelly. The most abundant copepod species was *A. robustus* (39972±56150.07 ind. m^{-3}) in Suat Uğurlu Dam Lake followed by *A. robustus* (first station, 8763±13745.11 ind. m^{-3}), *E. gracilis* (Hasan Uğurlu Dam Lake, 4729±5196.18 ind. m^{-3}) and *A. robustus* (at 3. station, 4187±5783.53 ind. m^{-3}). The least abundant cladoceran species were *A. quadrangularis* (Hasan Uğurlu Dam Lake, 9±2.83 ind. m^{-3}) and copepod

Table 2. Medium rotifer abundance at sampling stations

Rotifera	1. station	2. station	3. station	SUDL (4)	Terce C (5)	HUDL (6)	HUDL (7)	TC (8T)	KC (8K)
Brachionus angularis	30±4.95	620±7.78	224±17.68	56±18.38	--	22±1.41	--	--	4167±2812.27
B. calyciflorus	--	--	--	1286±37.48	--	724±737.22	--	--	180±6.36
B quadridentatus	--	84±3.54	--	--	--	--	--	261±6.93	928±2.83
Lecane lunaris	--	--	--	--	--	--	--	--	273±122.78
L. bulla	--	182±12.73	--	--	--	--	--	--	314±4.95
B budapestinensis	--	--	--	--	--	--	--	--	391±7.78
Filinia longiseta	417±402.34	441±492.85	1412±12.73	485±470.84	--	133±119.09	36±1.41	--	1150±1600.18
Synchaeta pectinata	--	331±220.62	1287±8.49	139±103.15	--	3184±1648.42	8490±7.78	--	--
Polyarthra dolichoptera	572±124.43	654±627.29	3520±3550.05	18787±2115.81	--	6828±11802.24	7397±9838.40	--	--
Keratella cochlearis	681±1193.15	7434±1202.89	3870±4679.63	660±1257.39	222±7.78	33793±6047.88	3897±6753.05	228±191.39	9587±1110.93
Keratella quadrata	274±275.06	281±247.95	138±183.85	121±98.57	227±13.44	109±45.58	779±1090.61	--	219±68.82
Keratella tropica	--	--	38±4.24	20±4.95	--	--	--	--	--
Pompholyx sulcata	349±176.78	134±58.69	792±105.00	267±354.35	576±21.92	523±458.09	--	--	468±6.36
Cephalodella gibba	--	623±12.73	78±11.31	53±23.03	638±62.93	16±2.12	29±5.66	975±16.97	183±10.61
Notholca squamula	--	--	112±9.90	41±28.92	--	--	167±11.31	--	53±24.75
Notholca acuminata	24±2.83	--	118±18.38	--	--	15±4.95	81±8.49	--	885±5.66
Asplanchna priodonta	1337±1629.63	542±732.56	27±12.02	2497±3314.45	--	34861±8172.24	3092±2649.42	--	--
Trichocerca similis	--	102±4.95	--	1459±102.53	--	2656±2769.95	1615±23.33	--	343±4.24
Testudinella patina	--	--	--	--	--	--	--	212±78.49	--
Lepadella patella	--	--	--	--	--	--	--	146±22.63	--
Colurella uncinata	276±7.78	2083±12.73	--	658±2.83	--	--	--	235±6.36	--
Euchlanis dilatata	--	--	--	--	--	143±3.54	235±15.56	15±12.73	--
Lophocharis salpina	--	--	--	--	--	--	--	2419±16.97	--
Daphnia longispina	807±455.26	259±196.80	323±389.96	138±57.95	253±14.85	835±862.40	888±1582.66	--	23±6.36
D. galeata	1941±912.84	517±352.68	284±96.87	2279±2355.64	591±12.02	1847±1898.13	1750±2052.02	--	--
D. cucullata	850±8.49	29±3.54	22±4.95	171±8.49	--	--	--	--	--
Ceriodaphnia pulchella	5977±5635.26	527±241.06	1000±1238.85	4146±5625.97	614±11.31	6542±1146.07	2305±2569.45	2479±23.33	--
Bosmina longirostris	932±1278.80	237±188.81	195±160.64	680±879.36	368±15.56	1749±3385.40	1567±1367.31	--	2466±13.44
Diaphanosoma birgei	372±4.95	41±3.54	76±79.20	1095±1.41	--	15578±2160.42	6503±28.99	--	--
Alona quadrangularis	183±72.12	184±12.02	389±4.24	127±98.63	--	9±2.83	42±16.04	972±12.73	--
Disparalona rostrata	--	114±6.36	--	1252±1330.86	--	12±1.41	--	--	--
Pleuroxus aduncus	77±2.83	--	--	--	--	48825±148.49	8636±48.08	--	--
Chydorus sphaericus	2284±28.99	--	100±7.07	578±825.63	--	278±249.73	79±4.95	--	--
Simocephalus vetulus	--	--	--	27±5.66	--	--	--	--	--
Copepoda									
Cyclops vicinus	806±844.99	269±8.49	523±553.47	84±38.95	--	110±43.23	--	--	--
Eucyclops serrulatus	83±4.95	--	80±13.44	--	--	15±8.49	--	--	--
Thermocyclops dybowskii	--	--	116±14.85	1528±1655.09	--	733±820.70	--	--	--
Megacyclops viridis	416±7.78	708±8.49	533±9.19	20±2.83	--	--	--	--	27±12.02
Diacyclops sp.	287±256.68	--	521±21.92	--	--	261±214.22	143±9.19	--	--
Acanthocyclops robustus	8763±13745.11	1804±2700.37	4187±5783.53	39972±56150.07	573±4.95	3706±5112.21	3430±3399.67	1593±1375.33	218±4.95
Eudiaptomus gracilis	4055±8953.50	747±807.29	921±1292.87	1461±1964.06	979±8.49	4729±5196.18	2013±2298.09	--	1219±2087.68
Nitokra hibernica	--	--	--	2261±2766.30	--	--	--	--	1315±28.99

Table 3. Abundance of zooplankton in sampling time

	Sampling time					
Rotifera	April 2008	Jully 2008	November 2008	February 2009	June 2009	Jully 2009
Brachionus angularis	1399±2497.30	--	--	--	--	--
B. calyciflorus	180±6.36	--	1321±116.00	92±2.83	--	--
B quadridentatus	--	--	176±126.57	--	--	--
Lecane lunaris	173±3.54	--		--	--	--
L. bulla	--	--	245±101.82	--	--	--
B budapestinensis	--	--	402±95.26	--	--	--
Filinia longiseta	648±743.09	--	736±559.14	166±298.86	26±2.83	--
Synchaeta pectinata	791±1022.43	--	--	5316±3342.91	567±634.94	--
Polyarthra dolichoptera	1068±705.80	9060±17268.23	3433±3465.00	770±779.42	4636±7988.22	30115±17267.44
Keratella cochlearis	7915±10326.04	240±170.68	9143±14934.89	286±402.05	25335±62591.86	56679±83012.51
Keratella quadrata	141±103.26	131±73.68	247±44.50	234±146.08	46±23.57	1094±1335.72
Keratella tropica	25±9.61	--	--	--	--	--
Pompholyx sulcata	84±79.15	818±250.83	1019±607.40	81±82.29	--	--
Cephalodella gibba	180±225.70	689±9.19	--	216±417.61	73±4.24	--
Notholca squamula	49±38.49	--	--	102±63.00	--	--
Notholca acuminata	40±43.76	--	--	346±469.96	--	--
Asplanchna priodonta	60±21.73	1061±599.97	699±820.47	85±70.28	30598±52724.20	41222±93293.29
Trichocerca similis	--	--	1045±643.63	--	934±13.44	4213±3650.79
Testudinella patina	--	--	212±78.49	--	--	--
Lepadella patella	--	--	137±9.19	--	--	--
Colurella uncinata	--	--	778±752.79	--	--	--
Euchlanis dilatata	--	--	--	183±47.10	--	--
Lophocharis salpina	--	--	--	2396±15.56	--	--
Cladocera						
Daphnia longispina	380±441.14	199±37.16	798±769.33	230±414.69	718±879.87	1752±1556.47
D. galeata	--	569±480.30	--	--	1349±1115.60	3329±2138.27
D. cucullata	--	171±8.49	--	--	--	--
Ceriodaphnia pulchella	16±1.41	996±481.89	620±209.97	1909±3861.07	11190±14937.63	9206±4687.62
Bosmina longirostris	649±1033.45	149±139.86	304±225.62	1001±1153.49	1400±2526.22	3109±3523.04
Diaphanosoma birgei	--	2685±1623.52	711±410.54	--	43408±29.70	24980±26101.43
Alona quadrangularis	162±131.04	--	--	198±345.32	--	--
Disparalona rostrata	12±1.41	--	--	--	97±3.54	1829±1271.99
Pleuroxus aduncus	83±4.95	--	--	--	48911±26.87	28795±28461.05
Chydorus sphaericus	1184±1525.94	66±4.24	746±882.04	79±6.35	133±99.89	2027±15.56
Simocephalus vetulus	--	--	--	--	27±5.66	--
Copepoda						
Cyclops vicinus	308±378.77	--	136±9.90	321±536.78	--	--
Eucyclops serrulatus	45±34.89	--	--	--	--	--
Thermocyclops dybowskii	59±40.45	--	2194±903.05	96±2.83	--	--
Megacyclops viridis	249±293.14	--	--	--	--	--
Diacyclops sp.	86±21.83	--	--	366±171.14	--	--
Acanthocyclops robustus	181±68.38	6036±7556.96	1024±902.95	93±4.24	3754±4778.87	61211±61426.53
Eudiaptomus gracilis	1140±1711.43	776±621.22	3773±3366.51	3132±6759.13	2991±6079.07	6654±4936.19
Nitokra hibernica	--	--	--	1352±24.04	2261±2766.30	--

Eucyclops serrulatus (Fischer, 1851) (Hasan Uğurlu Dam Lake, 15±8.49 ind. m^{-3}).

P. dolichoptera, *K. quadrata*, *K. cochlearis* and *Asplanchna priodonta* Gosse, 1850 were found in all months. The species appeared in only one sampling period during the study were *Brachionus angularis* Gosse, 1851, *L. lunaris*, *L. bulla* Gosse, 1851, *B. budapestinensis*, *Keratella tropica* (Apstein, 1907), *Testudinella patina* (Hermann, 1783), *Lepadella patella* (Müller, 1773), *C. uncinata*, *Euchlanis dilatata* Ehrenberg, 1832 and *Lophocharis salpina* (Ehrenberg, 1834). The most abundant species was *K. cochlearis* (July 2009, 56679±83012.51 and 41222±93293.29 ind. m^{-3}) and followed by *A. priodonta* (June 2009, 30598±52724.20 ind. m^{-3}), and *P. dolichoptera* (July 2009, 30115±17267.44 ind. m^{-3}). The least abundant species was *K. tropica* obtained in April 2008 (25±9.61 ind. m^{-3}) (Table 3).

Cladoceran *D. longispina*, *C. pulchella*, *B. longirostris*, *Chydorus sphaericus* (O. F. Mueller, 1785), copepods *A. robustus* and *E. gracilis* were observed at all sampling months but cladocer *Daphnia cucullata* Sars 1862 (July 2008), copepods *Megacyclops viridis* (Jurine, 1820) and *E. serrulatus* (April 2008) were obtained in only one sampling month. The most abundant species were copepod *A. robustus* (July 2009, 61211±61426.53 ind. m^{-3}) and cladoceran *P. aduncus* (June 2009, 48911±26.87 ind. m^{-3}). Other abundant species were cladoceran *D. birgei* (June 2009, 43408±29.70 ind. m^{-3}), *P. aduncus* (July 2009, 28795±28461.05 ind. m^{-3}), *D. birgei* (July 2009, 24980±26101.43 ind. m^{-3}), copepod *E. gracilis* (July 2009, 6654±4936.19 ind. m^{-3}), *A. robustus* (July 2008, 6036±7556.96 ind. m^{-3}) and *E. gracilis* (3773±3366.51 ind. m^{-3}). The least abundant species from Cladocera were *Disparalona rostrata* (Koch, 1841) (April 2008, 12±1.41 ind.m^{-3}) and copepod *E. serrulatus* (April 2008, 45±34.89 ind.m^{-3}).

The mean rotifer, cladocer and copepod abundance was higher in Suat Uğurlu Dam Lake (rotifer 6385±1255.23 ind. m^{-3}; cladocer 8408±1296.88 ind. m^{-3} copepod 7554±1590.61 ind. m^{-3}). Averaging for abundance of all zooplankton, Hasan Uğurlu Dam Lake was rich in zooplankton abundance (7554±1590.61 ind. m^{-3}) (Figure 4). Temporal variation in total abundance of zooplankton was given in Figure 5. The most dominant rotifer (10944±1191.53 ind. m^{-3}), copepod (20601±2491.86 ind. m^{-3}) and total zooplankton (9672±12231.09 ind. m^{-3}) were obtained in July 2009 and cladocer in June 2009 (11915±1977.05 ind. m^{-3}).

Discussion

A total of 42 zooplankton taxa consisting of Rotifera (23), Cladocera (11), and Copepod (8) were identified during the study. According to Saksena (1987), Rotifera qualitative and quantitative is the dominant group among all zooplankton groups in freshwater ecosystem. The result obtained in this study was accordance with results of Saksena (1987). Many studies on zooplankton were done in lotic and lentic system in Turkey. The results of these studies indicated that the number of species and abundance of zooplankton varied among regions and ecological structures of the aquatic environment. For example,

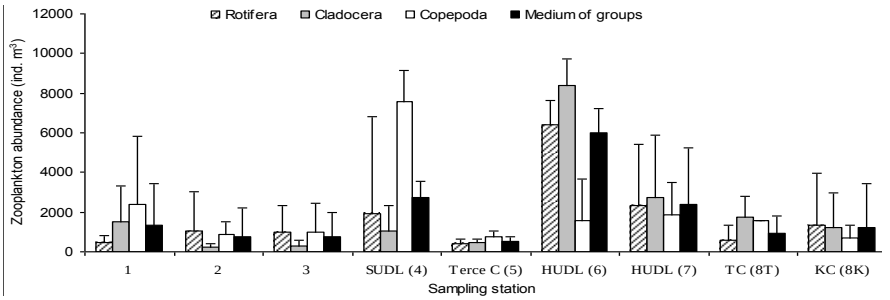

Figure 4. Mean abundance of groups (Rotifera, Cladocera and Copepoda) at stations. (SUDL (4): Suat Uğurlu Dam Lake, Terce C: Terce Creek, HUDL (6,7): Hasan Uğurlu Dam Lake, TC (8T): Tozanlı Creek, KC (8K): Kelkit Creek).

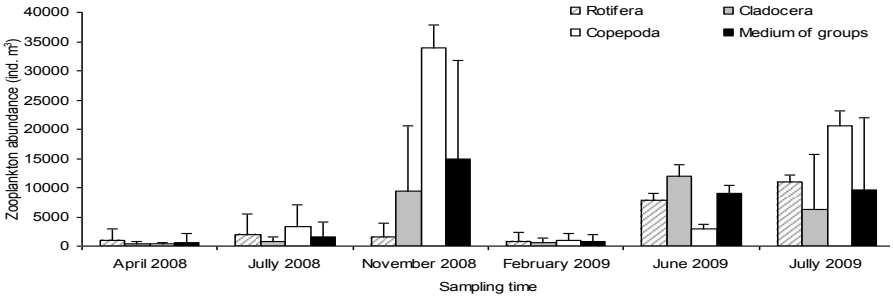

Figure 5. Seasonal abundance of zooplankton groups.

Bozkurt and Güven (2010) declared 58 rotifer taxa, 16 cladocer taxa and 15 copepod taxa, 89 taxa in total in Asi River (Hatay). Bozkurt (2004) identified 48 rotifer species, 14 cladocer species and 8 copepod species in 6 different lotic systems (Ceyhan River, Seyhan River, Manavgat River, Savrun, Keşiş Brook, Deliçay). Balık *et al*. (1999) found 12 of Rotifer, 18 of cladocer and 6 of copepod species in rivers at North Aegean Region (Gediz River, Güzelhisar Brook and Bakırçay). Balık *et al*. (1999) indicated that species richness of aquatic systems is higher in the hot-climate zone especially in Mediterranean region (as in Asi River).

The same situation was observed in dam lakes. Results of some studies were as follow: totally 54 species were declared in Aslantaş Dam Lake, including 35 Rotifera, 14 Cladocera, and 5 Copepoda (Bozkurt *et al*., 2009; Bozkurt and Göksu, 2010); totally 39 taxa declared, containing 21 rotifer, 11 cladocer and 7 copepod in Birecik Dam Lake (Bozkurt and Sağat, 2008). Some others; 11 rotifer, 7 cladocer and 1 copepod, 19 species in total in Çamlıgöze Dam Lake, (Dirican and Musul**,** 2008); 2 cladocer, 5 copepod, 17 species in total in Devegeçidi Dam Lake, (Bekleyen, 2006); 8 cladocer, 2 copepod, 10 species in total in Çatalan Dam Lake, (Aladağ *et al*., 2006); 18 rotifer, 9 cladocer and 4 copepod, 31 species in total in Hirfanlı Dam Lake, (Yiğit and Altındağ, 2005); 11 rotifer in Kesikköprü Dam Lake (Yiğit, 2002); 21 rotifer, 7 cladocer and 4 copepod, 32 species in total in Kurtboğazı and Çamlıdere Dam Lakes (Demir, 2005); 8 cladocer and 4 copepod, 12 species in total in İkizcetepeler Dam Lake, (Alper *et al*., 2007); 34 rotifer at Devegeçidi Dam Lake (Bekleyen, 2001) and 28 rotifer, 16 cladocer and 3 copepod, 47 species in total were declared (Bekleyen, 2003).

In rivers and dam lakes, as it can be seen in theese studies, zooplankton faunal structure varies among regions and even among aquatic environment. These differences were due to trophic status of water, regional temperature, age of aquatic environment and ecological features of existed species.

The species obtained in the study, *B. calyciflorus* Pallas, 1766, *B. quadridentatus* Hermann, 1783, *K. cochlearis*, *K. quadrata*, *N. squamula*, *Lecane (M.) lunaris* (Ehrenberg, 1832), *L. (M.) bulla* (Gosse, 1851), *C. gibba*, *P. dolichoptera*, *T. patina*, *F. longiseta*, *B. angularis*, *D. longispina*, *Simocephalus vetulus* (Müller, 1776), *B. longirostris*, *P. aduncus*, *C. sphaericus*, *Cyclops vicinus* Uljanin, 1875, *A. robustus*, *M. viridis* and *Nitocra hibernica* (Brady, 1880) are reported to be found in many aquatic environment and cosmopolite species and have wide distribution area (Altındağ and Yiğit, 1999; Bekleyen, 2003; Saler and Şen, 2002; Saler, 2004).

Some zooplankton species were reported to be associated with the vegetated parts of lakes. It has been reported that *Lecane* is generally found in littoral and benthic regions and is not a migratory species (Ruttner-Kolisko, 1974). *N. squamula* has been reported to be found in freshwater and salt water (Saler and Şen, 2000). *B. quadridentatus*, *L. bulla*, *L. lunaris* were reported to be cosmopolite species and found in river, lentic and brackish water of semitropical areas (Emir, 1990; Eldredge and Evenhuis, 2003). *Testudinella* was found associated with vegetated areas of lakes and also in the aquatic system with low salinity and temperature, *E. dilatata* was found in littoral and vegetated areas of the rivers and species of *Trichocerca* were reported to be abundant in littoral region of the river (Eldredge and Evenhuis, 2003). While Edmondson (1959) stated that cladoceran *S. vetulus* is found in vegetated areas of the rivers, Beklioğlu and Moss (1999) stated *Simocephalus* are zooplankton groups living dependent on aquatic plants. Gündüz (1991) reported that *A. rectangula* were found mostly in permanent water systems *C. sphaericus* is cosmopolite species and found in vegetated areas of the river and pools, *Daphnia* can be found in different aquatic environments ranging from larger lakes to ponds and from temporarily hard water to various rivers (Edmondson, 1959). *Pleuroxus* are cosmopolite (Gündüz, 1986), *P. aduncus* are found in vegetated areas of lakes and pools (Edmondson, 1959). Moreover, *P. dolichoptera* were reported to be found in the lakes and pools having rich oxygen at each season (Ruttner-Kolisko, 1974). It was observed that the findings were compatible with the literature data and the explored species were generally durable and appear in many areas.

B. angularis, *B. quadridentatus*, *K. cochlearis*, *K. quadrata*, *N. squamula*, *L. patella*, *L. bulla*, *F. longiseta*, *B. longirostris*, *A. rectangula*, *A. robustus*, *C. vicinus* that are known to be indicator of eutrophication by many researchers. These species are usually found in freshwater at temperate zone. We in this study also found this species in Yeşilırmak River and dam lakes built on it.

According to previous studies, rotifers are more sensitive to environmental changes than cladocerans and copepods, and are known to be characteristic indicators of water quality (Gannon and Stemberger, 1978). Furthermore, Sladecek (1983) and Saksena (1987) indicated that species of rotifer were bioindicator of water quality and rotifer density was characteristic of eutrophic waters according to Sendac (1984). Cladoceran *B. longirostris* were densely found in eutrophic waters (Ryding and Rast, 1989). In addition, it can be stated that the river gives the impression of being eutrophic because of long distances until flowing into the sea and agricultural operations at the route.

Many species identified in this study, (*B. quadridentatus*, *B. angularis*, *B. calyciflorus*, *B. budapestinensis*, *C. gibba*, *L. bulla*, *L. lunaris*, *L. patella*, *K. cochlearis*, *K. quadrata*, *S. pectinata*, *P. dolichoptera*, *A. priodonta*, *F. longiseta*, *T. patina*, *N. squamula*, *E. dilatata*, *B. longirostris*, *A. rectangula*,

C. sphaericus, *P. aduncus*, *A. robustus*, *M. viridis*) are cosmopolite and appear in pelagic area and aquatic macrovegetation (Hutchinson, 1967; Ruttner-Kolisko, 1974; Margalef *et al*., 1976; Braioni and Gelmini, 1983; Koste and Shiel, 1986, 1987; Ramdani *et al*., 2001).

The species explored in the study, *B. quadridentatus*, *L. patella*, *L. bulla*, *E. dilatata* are reported in small lentic water and commonly in warm rivers (Ruttner-Kolisko, 1974; Braioni and Gelmini, 1983; Koste and Shiel, 1987). *K. tropica* and *K. quadrata* are durable to high changes in temperature and appear among plants in lentic water and slow flowing waters and are common in summer (Hutchinson, 1967; Braioni and Gelmini, 1983); *T. patina* that are less durable to temperature changes frequently occur in spring and autumn (Braioni and Gelmini, 1983). *A. robustus* and *C. vicinus* appear in lakes, rivers, marshes, littoral zone in all types aquatic environment such as small waters and prefer hot waters (Dussart, 1969).

According to Koste (1978), some of *Brachionus* species (*B. angularis*, *B. falcatus*, *B. budapestinensis*, *B. calyciflorus*, *B. urceolaris*) prefer warmer zone and are frequent in trophic and subtrophic waters during summer; Ruttner-Kolisko (1974) reported that *N. squamula* is stenoterm species preferring cold zone and found frequently in algal lakes. The findings in our study are generally parallel with the results of other studies and many species appear in the rivers and they are cosmopolite. Especially, *Brachionus* species, in the view of Koste (1978), appear mostly in summer months, *N. squamula* is found in the colder season. *T. patina* is commonly found in spring months at which the temperature is not too high, as parallel with data in the literature. Divergently, species of *K. tropica* and *K. quadrata* appeared in colder months in our study. Moreover, species composition of zooplankton observed in dams on Yeşilırmak River were generally cosmopolite and indicator eutrophication, but the abundance of these type of species was lower than that found in eutrophic waters.

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