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Research Article

Determination of zooplankton fauna in the running waters of Arsuz District of Hatay province

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ABSTRACT

Some water quality parameters (salinity, water temperature, conductivity and dissolved oxygen) and zooplankton fauna were investigated in 4 rivers within the borders of Arsuz district of Hatay Province. Forty three (43) species of Rotifera (61.43%), 21 species of Copepoda (30%), and 6 species of Cladocera (8.57%) were recorded. In the study, 15 families from Rotifera were recorded, Lecanidae was the richest family with 12 species, Chydoridae from Cladocera represented by three families was the richest family with 4 species, and Cyclopoidae from Copepoda, represented by 10 families, was the richest family with 8 species. It was observed that *Cephalodella gibba, Colurella adriatica, Eucyclops serrulatus* and *Paracyclops fimbriatus* were the most common species recorded in all four running waters. Most species (51 species) were recorded in Arsuz Stream, followed by Gümüşkent stream with 32 species. In the study in which a total of 70 taxa were recorded, only 12 taxa were very abundant (+++) and abundant (++) levels in various seasons and rivers. Only 2 rotifer species *Brachionus quadridentatus* and *Lecane hamata* were very abundant. There was a significant and positive relationship between zooplankton species diversity, abundance, and water quality parameters.

Introduction

Zooplankton plays an important role in the integration of the energy budget into the aquatic ecosystem by controlling phytoplankton production and grazing on primary producers and organic residues in the water column, which play a key role in the food web by shaping the pelagic ecosystem (Anene, 2003). They play an important role in the aquatic food web because they provide food for many aquatic organisms. As fish depend on them nutritionally, they are useful indicators of the future of fisheries and fish health (Davies et al., 2009). Zooplankton are useful as bioindicators to help us detect pollution load, but are also useful for remediating polluted waters (Mukhopadhyay et al., 2007; Eyo et al., 2013). They are also key in determining the amount and composition of particles that sink into benthos, which provide nutrients for benthic organisms and contribute to the burial of organic compounds. What zooplankton feeds on is not always clear as it depends on life stage, season and food availability. But in general, they can be grouped into herbivores that eat only phytoplankton, omnivores that eat both phytoplankton and zooplankton, and carnivores that eat only other zooplankton, and detritivores that eat detritus and bacteria (Wetzel, 2001).

Flowing aquatic environments, such as rivers, provide a distinct, complex habitat for zooplankton and may be home to a plethora of microzooplankton (Kobayashi et al., 1998). River zooplankton assemblages can have the structure and function of rivers, as opposed to lacustrine zooplankton assemblages, which are typically dominated by larger cladocerans and copepods (Cyr and Pace, 1993).

Rivers often contain abundant plankton, although zooplanktonic organisms lack the ability to swim against currents (Hynes, 1970; Rzoska, 1978). Factors affecting plankton abundance in rivers are broadly divided into two categories: factors affecting the transport of organisms from source areas to the river and factors affecting the growth and reproduction of organisms in the river (Hynes, 1970). Plankton can be supplied to the river by stagnant waters in contact with the canal. Natural lakes and dams are obvious examples, but stagnant waters, braided channels with low flow, can be even more important in unmodified rivers. Incubation of eggs resting in river sediments may also help zooplankton populations develop in rivers (Moghraby, 1977). The fate of plankton within the river channel is largely determined by the organisms' ability to grow and reproduce. Plankton density

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increases downstream in some large rivers, indicating that populations can multiply (Greenberg, 1964). Increases, on the other hand, may vary seasonally with runoff or may not occur at all (Hynes, 1970).

Although zooplankton of stagnant waters was widely researched in Turkey, studies on rivers are relatively few. Some of these are Rotifer Fauna of Gümüldür Stream (İzmir) (Ustaoğlu et al., 1996), Rotifera and Cladocera fauna of Seyhan River (Göksu et al., 1997), Cladocera and Copepoda fauna of Gümüldür Stream (Ustaoğlu et al., 1997), rotifer fauna of Zıkkım Stream and seasonal changes (Saler and Şen, 2001), zooplankton fauna of some rivers in the Mediterranean Region (Bozkurt, 2004), Rotifera fauna of the Euphrates River basin (Akbulut and Yıldız, 2005), rotifer fauna of Seli Stream (Elazig-Turkey) (İpek and Saler, 2008), zooplankton structure in Karaman stream (Altındağ et al., 2009), Asi River (Hatay-Turkey) zooplankton succession (Bozkurt and Güven, 2010), Zooplankton of Karasu River (Erzincan) (Saler et al., 2015), Zooplankton and Variation of Murat River (Bulut and Saler, 2014), rotifer fauna of Gediz River Basin, Turkey (Ergönül et al., 2015), Rotifera Fauna and Community Structure of Tunca River (Edirne) (Güher and Demir, 2018).

This study was carried out to determine the zooplankton fauna of 4 running waters, namely Arsuz Stream, Gümüşkent Creek, Çengen Village Creek and Büyükdere Village Creek, which are between the districts of Iskenderun and Arsuz within the borders of Hatay province, where no studies have been conducted so far.

Materials and Methods

Zooplankton samples were collected from five stations located within Hatay Province, between the districts of Iskenderun and Arsuz (Figure 1). Table 1 shows the coordinates of the stations. Zooplankton samples were collected seasonally from Arsuz Stream, Gümüşkent Creek, Çengen Village Creek, and Büyükdere Village Creek in July 2021, October 2021, January 2022, and April 2022. The samples were collected using a plankton net from the water and interstitial at two stations in the Arsuz Stream and one station in each of the other streams. Samples were taken with a plankton net of 60 µm mesh size, 30 cm mouth diameter and 1 m length. Due to the fact that the river zooplankton fauna is poor in terms of quality and quantity, sampling was carried out from the flowing part of the water for approximately 25-30 minutes by keeping the plankton net constant. Interstitial samples were collected by the Karaman–Chappuis method (Delamare-Deboutteville, 1960). On the side of the stream, in sandy gravel areas under the influence of water, pits 30-40 cm deep and 50-60 cm wide (to the extent allowed) were dug and the water accumulated in them was poured into the plankton bucket with the help of a container and filtered (after the water in the pool was exhausted, it was expected to be filled again and drained). Samples taken by both methods were placed in 500 cc plastic containers and preserved in 4% formaldehyde.

While the plankton samples were taken from the water at all stations, they were also taken from the sand at the 2nd, 3rd and 4th stations. Sampling was not possible at stations 4th and 5th as there was no water summer and autumn.

Arsuz Stream is a significant stream in the Arsuz district that originates in the Amanos and grows by connecting various small running water branches to reach a length of approximately 20 kilometers. This stream contains the first and second stations. The Gümüşkent Stream is approximately 17 kilometers long, with a seasonal flow rate due to the merging of small streams originating from the Amanos Mountains, and the 3rd station is located on this stream. The Çengen Village Stream is a small running water with a length of around 5 km, which dries up in summer and autumn, and the 4th station was determined in this stream. The Büyükdere Village Stream is fed by spring water, leachate, and rain water that originates near Pirinçlik Village in Arsuz district and travels approximately 8 kilometers. Its waters drop significantly in the summer and autumn, and the 5th station is located on this stream.

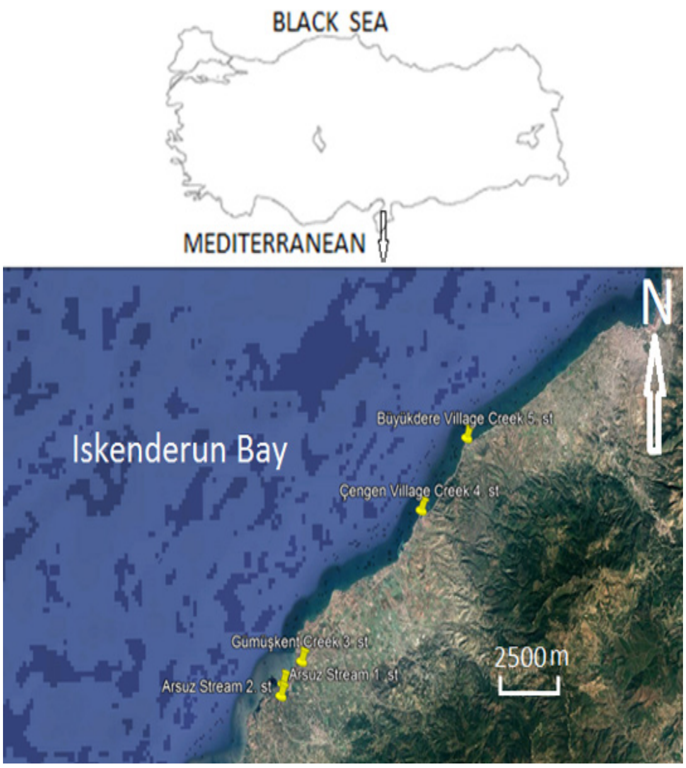

Figure 1. Sampling stations

Water temperature (°C) and dissolved oxygen (mg L^{-1}) were determined in-situ with a model YSI-52 oxygen meter, salinity (ppt) and conductivity (µS cm^{-1}) with a model YSI-30 salinometer.

Zooplankton species were examined and identified using an inverted microscope and a binocular microscope (Olympus CH40). The specimens were identified using Rylov (1963), Borutsky (1964), Scourfield and Harding (1966), Dussart (1967), Dussart (1969), Damian-Georgescu (1970), Smirnov (1974), Negrea (1983), Reddy (1994), Segers (1995), Karaytug (1999), Holynska et al. (2003) and the relevant literature.

Table 1. Sampling location and coordinates

Station	Streams	Station coordinates
1	Arsuz Stream	36° 24' 22.23" N, 35° 53' 15.09" E
2	Arsuz Stream	36° 24' 00.12" N, 35° 53' 08.58" E
3	Gümüşkent Creek	36° 25' 40.46" N, 35° 54' 16.35" E
4	Cengen Village Creek	36° 29' 39.47" N, 35° 59' 58.29" E
5	Buyukdere Village Creek	36° 31' 52.20" N, 36° 02' 12.50" E

Results

In the study, some water quality parameters such as salinity, water temperature, conductivity and dissolved oxygen were measured during the sampling in the field. Accordingly, it was determined that the highest salinity was 3 ppt in the summer and autumn at the 1st station, and the lowest was 0.2 ppt in the winter at the 1st station and the annual average was 0.79±0.88 ppt. With an annual average of 21.79±6.64 °C, the highest temperature was 32.4 °C in the spring at the fourth station and the lowest was 11.2 °C in the winter at the second station. The maximum dissolved oxygen concentration was 11.22 mg L^{-1} at station 4 in winter, while the lowest concentration was 7.60 mg L^{-1} in summer with an annual average of 8.67±0.82 mg L^{-1}. Conductivity was highly variable throughout the year. The maximum reading was 1646 μS cm^{-1} in winter at the 4th station, 360 μS cm^{-1} at the 2nd station in winter, and the annual average was 915.19±464.14 μS cm^{-1} (Table 2).

Forty three (43) species of Rotifera (61.43%), 21 species of Copepoda (30%), and 6 species of Cladocera (8.57%) were recorded in the study (Table 3). A total of 15 families were recorded among the rotifers. The family Lecanidae was the most abundant with 12 species, followed by Lepadellidae with 8 species, Brachionidae with 5 species, Trichocercidae and Notommatidae with 3 species each, and Euchlanidae and Trichotridae with 2 species each. Three families were recorded among Cladocera. Chydoridae was the richest family with 4 species (Table 3). Among the 10 families of Copepoda, Cyclopoidae had 8 species, followed by Canthocamptidae with 4 species and Ameiridae with 2 species.

Each of the other families belonging to the rotifer, cladoceran and copepod groups in the study were represented by only one species (Table 3).

When the running waters in which the research was carried out were evaluated separately, the zooplankton content of each stream was quite different, although the zooplankton fauna of all of them consisted of common species.

According to this; a total of 51 species, 36 rotifers, 12 copepods, and 3 cladocerans, were determined from the Arsuz Stream plankton and interstitial samples. While Gumuskent Stream was found in the second abundance with a total of 32 species, 22 rotifers, 8 copepods and 2 cladocerans, it was followed by the Cengen Village Stream with a total of 17 species, 9 rotifers, 6 copepods and 2 cladocerans. The least species was recorded in the Büyükdere Village Creek, where there were a total of 16 species, 7 copepods, 5 rotifers and 4 cladocerans.

The species recorded in all four streams were *C. gibba, C. adriatica* and *E. serrulatus*. Of the species found in three streams, *E. dilatata, C. rectangula, Speocyclops* sp. (Arsuz Stream, Gümüşkent Creek, Büyükdere Village Creek), *L. closterocerca, L. hamata, L. luna, K. xanthi, N. stammeri* (Arsuz Stream, Gümüşkent Creek, Çengen Village Creek), *L. ovalis* (Arsuz Stream, Cengen Village Creek, Büyükdere Village Creek), *P. fimbriatus* (Gumuskent Creek, Cengen Village Creek, Büyükdere Village Creek).

Species recorded in two streams, *B. quadridentatus, E. brachionus, L. bulla, L. furcata, L. papuana, L. pyriformis, L. patella, R. neptunia, T. patina, T. weberi, M. laticornis* (Arsuz Stream, Gümüşkent Creek), *C. colurus, T. tetractis* (Arsuz Stream, Çengen Village Creek), *L. curvicornis, M. viridis* (Gümüşkent Creek, Büyükdere Village Creek), *L. acanthocercoides, P. aduncus, M. mehmetadami* (Çengen Village Creek, Büyükdere Village Creek), *A. crassa, B. minutus* (Arsuz Stream, Büyükdere Village Creek).

Species recorded in only one stream were *C. forficula, C. uncinata, C. iskenderunensis, D. epicharis, L. flexilis, L. ludwigi, L. acuminata, L. (Heterolepadella) ehrenbergi, L. rhomboides, L. salpina, Ptygura* sp., *S. longicaudum, T. similis, T. taurocephala, T. pocillum, T. plicata, I. sordidus, C. perplexa, Ectinosoma* sp., *E. richardi, E. acutifrons, L. brevicornis, M. aestuarii* (Arsuz Stream), *B. calyciflorus, B. falcatus, B. urceolaris, Eothinia elongata, L. furcata, L. tenuiseta, M. grandispinifer, P. viguieri* (Gümüşkent Creek), *B. plicatilis, Diacyclops* sp., *D. bicuspidatus, N. kosswigi, Schizopera* sp. (Çengen Village Creek), *C. sphaericus* (Büyükdere Village Creek).

The most rotifer species were found in the 2nd station with 21 species in summer. This was followed by Station 1 with 20 species in the autumn and 19 species in the summer, and Station 2 in the autumn with 18 species. While no rotifers were recorded in the interstitial of the 3rd station in the winter and spring, 1 species was recorded in the interstitial samples of the 2nd station in the winter (Table 4). The most cladoceran was recorded in plankton samples with 3 species at station 2 in the summer and station 5 in the spring (Table 4). The most copepod species were recorded in the interstitial samples of station 2 with 9 species in the summer. This was followed by 5th station plankton samples in the winter with 6 species, 2nd station in interstitial with 5 species in the spring, 4th station plankton samples in the winter, and 2nd station in interstitial samples in the autumn (Table 4).

The most zooplankton was recorded in the 2nd station plankton samples in the summer with 25 species. This was followed by the summer and autumn 1st station plankton samples with 22 species, the autumn 2nd station plankton samples with 21 species, and the 2nd station interstitial samples in summer with 20 species. During the winter, no zooplankton was recorded in the interstitial samples of the 3rd station, but only one species was recorded in the same season in the interstitial samples of the 2nd station.

Table 2. Seasonal water quality parameters

Station	Parameter	Summer 2021	Fall 2021	Winter 2022	Spring 2022	Annual Mean
1	Salinity (ppt)	3.0	3.0	0.2	0.7	1.73±1.49
	Temp. (°C)	23.3	23.1	11.9	21.2	19.88±5.40
	Conduc. (μS cm^{-1})	1540	1602	366	960	1117±578.16
	DO (mg L^{-1})	8.00	8.26	9.10	8.65	8.50±0.48
2	Salinity (ppt)	0.4	0.3	0.3	0.3	0.32±0.05
	Temp. (°C)	28.1	25.7	11.2	24.5	22.38±7.60
	Conduc. (μS cm^{-1})	548	476	360	530	478.5±84.72
	DO (mg L^{-1})	8.40	8.80	9.10	8.45	8.69±0.33
3	Salinity (ppt)	0.7	0.3	0.6	0.5	0.53±0.17
	Temp. (°C)	24.6	29.1	13.5	22.3	22.38±6.56
	Conduc. (μS cm^{-1})	592	617	780	1046	758.75±208.86
	DO (mg L^{-1})	7.60	8.01	9.09	8.60	8.33±0.66
4	Salinity (ppt)	-	-	0.6	0.8	0.7±0.14
	Temp. (°C)	-	-	12	32.4	22.2±14.43
	Conduc. (μS cm^{-1})	-	-	1646	1630	1638±11.31
	DO (mg L^{-1})	-	-	11.22	7.95	9.585±2.31
5	Salinity (ppt)	-	-	0.5	0.5	0.5±0
	Temp. (°C)	-	-	18.21	27.6	22.91±6.64
	Conduc. (μS cm^{-1})	-	-	990	960	975±21.21
	DO (mg L^{-1})	-	-	8.92	8.49	8.71±0.30
	Annual averages across all sampling sites					
Salinity (ppt)						**0.79±0.88**
Temp. (°C)						**21.79±6.64**
Conduc. (μS cm^{-1})						**915.19±464.14**
DO (mg L^{-1})						**8.67±0.82**

*-: Sampling and measurement could not be made due to lack of water.

As a result of quantitative analysis, it was observed that zooplankton abundance was generally low. In the study in which a total of 70 taxa were recorded, only 12 taxa were very abundant (+++) and abundant (++) levels in various seasons and rivers, while other species were fewer amounts. *B. quadridentatus* and *L. hamata* were recorded very abundant in plankton samples at station 3 in the summer. The abundant species was *B. quadridentatus* (summer, 3rd station, interstitial), *E. brachionus* (autumn, 3rd station, in plankton), *L. bulla* (summer 3rd station in plankton samples and interstitial, autumn in 1st and 2nd station in plankton samples), *L. closterocerca* (Summer, 1st, 2nd and 3rd stations in plankton samples), *L. hamata* (1st and 2nd stations, plankton in Summer, 1st station plankton in autumn), *L. luna* (2nd station plankton samples in summer), *L. papuana* (Autumn in 2nd station), *Lepadella patella* (Summer 2nd station, plankton samples, Autumn, 3rd station, plankton samples), *R. neptunia* (Summer, 3rd station, plankton samples), *T. tetractis* (Summer, 2nd station, plankton samples), *C. adriatica* (Spring, 4th station, plankton and interstitial) and *Speocyclops* sp. (Spring 2nd station, interstitial).

Species recorded only once at any time and station during the study period, *B. calyciflorus, L. flexilis, L. ludwigi, L. tenuiseta, Lepadella acuminata, L. (Heterolepadella) ehrenbergi, L. rhomboides, Ptygura* sp., *T. similis, Tripleuchlanis plicata, C. sphaericus, C. perplexa, D. bicuspidatus, E. acutifrons, L. brevicornis, N. kosswigi, P. viguieri*; twice recorded species were *B. urceolaris, C. iskenderunensis, L. curvicornis, L. pyriformis, S. longicaudum, I. sordidus* and *L. acanthocercoides*. While these species were not discovered in interstitial samples and were only recorded in plankton samples, *B. falcatus* and *Schizopera* sp. were only recorded in interstitial samples once (Table 4). The ecological aspects of these species have not been discussed because of their rarity. On the contrary, the species recorded more than twice in the plankton samples during the study were *C. colurus* (found 3 times), *C. uncinata* (4), *L. ovalis* (9), *Lophocharis salpina* (3), *T. patina* (3), *T. pocillum* (7), *P. aduncus* (3) which was never found in the interstitial samples (Table 4). Other species were recorded in plankton and interstitial samples according to different seasons and stations.

Identified species showed different distributions according to seasons throughout the year. *C. gibba, C. adriatica, E. dilatata, L. closterocerca, L. hamata, L. luna, Lepadella ovalis, T. pocillum,*

Table 3. Taxa in the study

Rotifera
Brachionidae
Brachionus calyciflorus (Pallas, 1766)
Brachionus falcatus (Zacharias, 1898)
Brachionus plicatilis (Müller, 1786)
Brachionus quadridentatus (Hermann, 1783)
Brachionus urceolaris (Müller, 1773)
Notommatidae
Cephalodella forficula (Ehrenberg, 1830)
Cephalodella gibba (Ehrenberg, 1830)
Eothinia elongata (Ehrenberg, 1832)
Cotylegaleatidae
Cotylegaleata iskenderunensis (De Smet and Bozkurt, 2016)
Dicranophoridae
Dicranophorus epicharis (Harring & Myers, 1928)
Epiphanidae
Epiphanes brachionus (Ehrenberg, 1837)
Euchlanidae
Euchlanis dilatata (Ehrenberg, 1832)
Tripleuchlanis plicata (Levander, 1894)
Lecanidae
Lecane bulla (Gosse, 1886)
Lecane closterocerca (Schmarda, 1859)
Lecane curvicornis (Murray, 1913)
Lecane flexilis (Gosse, 1886)
Lecane furcata (Murray, 1913)
Lecane hamata (Stokes. 1896)
Lecane ludwigi (Eckstein, 1893)
Lecane luna (Müller, 1776)
Lecane papuana (Murray, 1913)
Lecane pyriformis (Daday, 1905)
Lecane stenroosi (Meissner, 1908)
Lecane tenuiseta Harring, 1914
Lepadellidae
Lepadella acuminata (Ehrenberg, 1834)
Lepadella (Heterolepadella) ehrenbergi (Petry, 1850)
Lepadella ovalis (Müller, 1786)
Lepadella patella (Müller, 1773)
Lepadella rhomboides (Gosse, 1886)
Colurella adriatica Ehrenberg, 1831
Colurella colurus (Ehrenberg, 1830)
Colurella uncinata (Müller, 1773)
Mytilinidae
Lophocharis salpina (Ehrenberg, 1834)
Flosculariidae
Ptygura sp.
Philodinidae
Rotaria neptunia (Ehrenberg, 1830)
Scaridiidae
Scaridium longicaudum (Müller, 1786)
Testudinellidae
Testudinella patina (Hermann, 1783)
Trichocercidae
Trichocerca similis (Wierzeski, 1893)
Trichocerca taurocephala (Hauer, 1931)
Trichocerca weberi (Jennings, 1903)
Trichotriidae
Trichotria pocillum (Müller, 1776)
Trichotria tetractis (Ehrenberg, 1830)
Cladocera
Chydoridae
Coronatella rectangula (Sars, 1862)
Chydorus sphaericus (Müller, 1776)
Leydigia acanthocercoides (Fischer, 1854)
Pleuroxus aduncus (Jurine, 1820)
Ilyocryptidae
Ilyocryptus sordidus (Liévin, 1848)
Macrothricidae
Macrothrix laticornis (Jurine, 1820)
Copepoda
Cyclopidae
Diacyclops sp.
Diacyclops bicuspidatus (Claus, 1857)
Eucyclops serrulatus (Fischer, 1851)
Megacyclops viridis (Jurine, 1820)
Metacyclops grandispinifer (Lindberg, 1940)
Monchenkocyclops mehmetadami (Karaytuğ, Bozkurt and Sönmez, 2018)
Paracyclops fimbriatus (Fischer, 1853)
Speocyclops sp.
Canthocamptidae
Attheyella crassa (Sars, 1863)
Bryocamptus minutus (Claus, 1863)
Epactophanes richardi (Mrázek, 1893)
Mesochra aestuarii (Gurney, 1921)
Canuellidae
Canuella perplexa (Scott and Scott, 1893)
Ectinosomatidae
Ectinosoma sp.
Tachidiidae
Euterpina acutifrons (Dana, 1847)
Parastenocarididae
Kinnecaris xanthi (Bruno and Cottarelli, 2015)
Darcythompsoniidae
Leptocaris brevicornis (Van Douwe, 1904)
Ameiridae
Nitocrella kosswigi (Noodt, 1954)
Nitocrella stammeri (Chappuis, 1938)
Phyllognathopodidae
Phyllognathopus viguieri (Maupas, 1892)
Miraciidae
Schizopera sp.

Table 4. Plankton abundance

Sampling Time	Summer 2021					Fall 2021				
Stations	**1**	**2**		**3**		**1**	**2**		**3**	
Species	**p**	**p**	**i**	**p**	**i**	**p**	**p**	**i**	**p**	**i**
Rotifera										
Brachionus calyciflorus	–	–	–	*	–	–	–	–	–	–
Brachionus falcatus	–	–	–	–	–	–	–	–	–	*
Brachionus plicatilis	–	–	–	–	–	–	–	–	–	–
Brachionus quadridentatus	*	–	–	+++	++	–	–	–	–	–
Brachionus urceolaris	–	–	–	–	–	–	–	–	*	–
Cephalodella forficula	*	*	*	–	–	–	–	*	–	–
Cephalodella gibba	*	+	+	*	–	*	*	*	*	–
Colurella adriatica	*	*	–	–	–	*	*	–	–	–
Colurella colurus	–	*	–	–	–	*	–	–	–	–
Colurella uncinata	–	–	–	–	–	*	*	–	–	–
Cotylegaleata iskenderunensis	–	*	–	–	–	–	–	–	–	–
Dicranophorus epicharis	–	*	–	–	–	–	*	–	–	–
Eothinia elongata	–	–	–	*	*	–	–	–	*	+
Epiphanes brachionus	*	–	–	*	–	–	–	–	++	*
Euchlanis dilatata	*	*	–	+	*	–	–	–	*	–
Lecane bulla	+	+	+	++	++	++	++	+	*	+
Lecane closterocerca	++	++	–	++	+	–	+	–	–	*
Lecane curvicornis	–	–	–	–	–	–	–	–	–	–
Lecane flexilis	–	–	–	–	–	+	–	–	–	–
Lecane furcata	–	–	–	*	*	*	*	–	–	–
Lecane hamata	++	++	*	+++	+	++	+	–	+	*
Lecane ludwigi	–	–	–	–	–	*	–	–	–	–
Lecane luna	+	++	+	+	+	+	+	*	*	–
Lecane papuana	–	*	–	+	*	+	++	+	+	+
Lecane pyriformis	*	–	–	–	–	–	–	–	*	–
Lecane stenroosi	*	–	*	–	–	+	+	+	–	–
Lecane tenuiseta	–	–	–	–	–	–	–	–	*	–
Lepadella acuminata	–	–	–	–	–	–	–	–	–	–
Lepadella (Heterolepadella) ehrenbergi	–	–	–	–	–	*	–	–	–	–
Lepadella ovalis	*	*	–	–	–	*	*	–	–	–
Lepadella patella	+	++	*	+	–	–	*	–	++	*
Lepadella rhomboides	–	–	–	–	–	–	*	–	–	–
Lophocharis salpina	–	*	–	–	–	*	+	–	–	–
Ptygura sp.	–	–	–	–	–	–	–	–	–	–
Rotaria neptunia	+	–	–	++	+	–	–	–	–	–
Scaridium longicaudum	*	*	–	–	–	–	–	–	–	–
Testudinella patina	*	–	–	–	–	–	–	–	–	–
Trichocerca similis	–	–	–	–	–	*	–	–	–	–
Trichocerca taurocephala	–	*	*	–	–	–	–	–	–	–
Trichocerca weberi		*	*	*	–	+	*	*	–	–
Trichotria pocillum	*	+	–	–	–	*	+	–	–	–
Trichotria tetractis	*	++	*	–	–	*	+	*	–	–
Tripleuchlanis plicata	+	–	–	–	–	–	–	–	–	–
Total rotifer species	**19**	**21**	**10**	**15**	**10**	**20**	**18**	**7**	**12**	**8**

(p: Plankton. i: interstitial. -: Absent, *: very few (1-10 individuals in each petri), +: few (10-30 individuals in each petri), ++: abundant (30-60 individuals in each petri), +++: very abundant (more than 60 individuals in a petri))

Table 4. Plankton abundance (continued)

Sampling Time	Summer 2021					Fall 2021				
Stations	**1**	**2**		**3**		**1**	**2**		**3**	
Species	**p**	**p**	**i**	**p**	**i**	**p**	**p**	**i**	**p**	**i**
Cladocera										
Coronatella rectangula	*	*	*	–	*	–	–	–	–	–
Chydorus sphaericus	–	–	–	–	–	–	–	–	–	–
Ilyocryptus sordidus	–	*	–	–	–	–	*	–	–	–
Leydigia acanthocercoides	–	–	–	–	–	–	–	–	–	–
Macrothrix laticornis	*	*	–	+	+	–	*	–	*	–
Pleuroxus aduncus	–	–	–	–	–	–	–	–	–	–
Total cladoceran species	2	3	1	2	2	0	2	0	1	0
Copepoda										
Diacyclops sp.	–	–	–	–	–	–	–	–	–	–
Diacyclops bicuspidatus	–	–	–	–	–	–	–	–	–	–
Eucyclops serrulatus	–	–	*	–	*	–	–	–	–	–
Megacyclops viridis	–	–	–	*	*	–	–	–	–	–
Metacyclops grandispinifer	–	–	–	–	–	–	–	–	+	+
Monchenkocyclops mehmetadami	–	–	–	–	–	–	–	–	–	–
Paracyclops fimbriatus	–	–	–	–	*	–	–	–	–	*
Speocyclops sp.	–	–	*	–	–	–	–	*	–	–
Attheyella crassa	–	–	*	–	–	–	–	*	–	–
Bryocamptus minutus	–	–	*	–	–	–	–	–	–	–
Canuella perplexa	–	–	–	–	–	*	–	–	–	–
Ectinosoma sp.	–	–	*	–	–	–	–	*	–	–
Epactophanes richardi	–	–	*	–	–	–	–	–	–	–
Euterpina acutifrons	*	–	–	–	–	–	–	–	–	–
Kinnecaris xanthi	–	–	+	–	–	–	–	*	–	–
Leptocaris brevicornis	–	–	–	–	–	*	–	–	–	–
Mesochra aestuarii	–	*	*	–	–	–	–	–	–	–
Nitocrella kosswigi	–	–	–	–	–	–	–	–	–	–
Nitocrella stammeri	–	–	*	–	*	–	–	*	–	–
Phyllognathopus viguieri	–	–	–	–	–	–	–	–	–	–
Schizopera sp.	–	–	–	–	–	–	–	–	–	–
Total copepod species	**1**	**1**	**9**	**1**	**4**	**2**	**0**	**5**	**1**	**2**
Total zooplankton species	**22**	**25**	**20**	**18**	**16**	**22**	**20**	**12**	**14**	**10**

(p: Plankton. i: interstitial. -: Absent, *: very few (1-10 individuals in each petri), +: few (10-30 individuals in each petri), ++: abundant (30-60 individuals in each petri), +++: very abundant (more than 60 individuals in a petri))

Table 4. Plankton abundance (continued)

Sampling Time	Winter 2022								Spring 2022							
Stations	1	2		3		4		5	1	2		3		4		5
Species	p	p	i	p	i	p	i	p	p	p	i	p	i	p	i	p
Rotifera																
Brachionus calyciflorus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Brachionus falcatus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Brachionus plicatilis	–	–	–	–	–	*	*	–	–	–	–	–	–	–	–	–
Brachionus quadridentatus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Brachionus urceolaris	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–
Cephalodella forficula	–	*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cephalodella gibba	–	*	*	*	–	+	+	+	–	*	+	*	–	*	+	*
Colurella adriatica	–	*	–	–	–	–	+	+	+	+	–	+	–	++	++	+
Colurella colurus	–	–	–	–	–	*	–	–	–	–	–	–	–	–	–	–
Colurella uncinata	–	–	–	–	–	–	–	–	*	*	–	–	–	–	–	–
Cotylogaleata iskenderunensis	–	–	–	–	–	–	–	–	*		–	–	–	–	–	–
Dicranophorus epicharis	–	–	–	–	–	–	–	–	*	*	+	–	–	–	–	–
Eothinia elongata	–	–	–	*	–	–	–	–	–	–	–	–	–	–	–	–
Epiphanes brachionus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Euchlanis dilatata	*	–	–	–	–	–	–	*	*	*	–	–	–	–	–	+
Lecane bulla	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lecane closterocerca	–	–	–	–	–	*	–	–	*	+	*	*	–	+	+	–
Lecane curvicornis	–	–	–	–	–	–	–	*	–	–	–	*	–	–	–	–
Lecane flexilis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lecane furcata	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lecane hamata	–	–	–	–	–	–	*	–	–	–	–	–	–	+	–	–
Lecane ludwigi	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–
Lecane luna	–	–	–	–	–	*	–	–	+	+	*	–	–	*	–	–
Lecane papuana	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lecane pyriformis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lecane stenroosi	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	*
Lecane tenuiseta	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lepadella acuminata	–	–	–	–	–	–	–	–	–	*	–	–	–	–	–	–
Lepadella (Heterolepadella) ehrenbergi	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lepadella ovalis	–	–	–	–	–	–	–	*	*	+	–	–	–	+	–	*
Lepadella patella	*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lepadella rhomboides	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lophocharis salpina	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ptygura sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rotaria neptunia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Testudinella patina	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Scaridium longicaudum	–	–	–	–	–	–	–	–	*	–	–	*	–	–	–	–
Trichocerca similis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Trichocerca taurocephala	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Trichocerca weberi	–	–	–	–	–	–	–	–	–	–	*	–	–	–	–	–
Trichotria pocillum	*	–	–	–	–	–	–	–	+	*	–	–	–	–	–	–
Trichotria tetractis	–	–	–	–	–	–	–	–	+	+	*	–	–	–	*	–
Tripleuchlanis plicata	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total rotifer species	**3**	**3**	**1**	**2**	**0**	**5**	**4**	**5**	**11**	**10**	**6**	**6**	**0**	**6**	**3**	**5**

(p: Plankton. i: interstitial. -: Absent, *: very few (1-10 individuals in each petri), +: few (10-30 individuals in each petri), ++: abundant (30-60 individuals in each petri), +++: very abundant (more than 60 individuals in a petri))

Table 4. Plankton abundance (continued)

Sampling Time	Winter 2022								Spring 2022							
Stations	**1**	**2**		**3**		**4**		**5**	**1**	**2**		**3**		**4**		**5**
Species	**p**	**p**	**i**	**p**	**i**	**p**	**i**	**p**	**p**	**p**	**i**	**p**	**i**	**p**	**i**	**p**
Cladocera																
Coronatella rectangula	+	*	–	–	–	–	–	–	+	+	*	–	–	–	–	*
Chydorus sphaericus	–	–	–	–	–	–	–	*	–	–	–	–	–	–	–	–
Ilyocryptus sordidus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Leydigia acanthocercoides	–	–	–	–	–	–	–	–	–	–	–	–	–	*	–	*
Macrothrix laticornis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pleuroxus aduncus	–	–	–	–	–	–	–	*	–	–	–	–	–	*	–	*
Total cladoceran species	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**1**	**1**	**0**	**0**	**2**	**0**	**3**
Copepoda																
Diacyclops sp.	–	–	–	–	–	*	*	–	–	–	–	–	–	–	–	–
Diacyclops bicuspidatus	–	–	–	–	–	–	–	–	–	–	–	–	–	*	–	–
Eucyclops serrulatus	–	–	–	–	–	*	–	*	–	–	–	–	–	–	–	*
Megacyclops viridis	–	–	–	–	–	–	–	*	–	–	–	–	–	–	–	–
Metacyclops grandispinifer	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monchenkocyclops mehmetadami	–	–	–	–	–	+	*	+	–	–	–	–	–	–	–	–
Paracyclops fimbriatus	–	–	–	–	–	–	–	*	–	–	–	*	*	+	*	*
Speocyclops sp.	–	–	–	–	–	–	–	*	–	–	++	*	*	–	–	*
Attheyella crassa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	*
Bryocamptus minutus	–	–	–	–	–	–	–	*	–	–	–	–	–	–	–	–
Canuella perplexa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ectinosoma sp.	–	–	–	–	–	–	–	–	–	*	–	–	–	–	–	–
Epactophanes richardi	–	*	–	–	–	–	–	–	–	–	*	–	–	–	–	–
Euterpina acutifrons	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Kinnecaris xanthi	–	–	–	–	–	–	*	–	–	*	+	–	*	–	–	–
Leptocaris brevicornis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mesochra aestuarii	–	–	–	–	–	–	–	–	+	+	+	–	–	–	–	–
Nitocrella kosswigi	–	–	–	–	–	*	–	–	–	–	–	–	–	–	–	–
Nitocrella stammeri	–	–	–	–	–	*	–	–	–	*	*	–	–	–	–	–
Phyllognathopus viguieri	–	–	–	–	–	–	–	–	–	–	–	*	–	–	–	–
Schizopera sp.	–	–	–	–	–	–	*	–	–	–	–	–	–	–	–	–
Total copepod species	**0**	**1**	**0**	**0**	**0**	**5**	**4**	**6**	**1**	**4**	**5**	**3**	**3**	**2**	**1**	**4**
Total zooplankton species	**4**	**5**	**1**	**2**	**0**	**10**	**8**	**13**	**13**	**15**	**12**	**9**	**3**	**10**	**4**	**12**

(p: Plankton. i: interstitial. -: Absent, *: very few (1-10 individuals in each petri), +: few (10-30 individuals in each petri), ++: abundant (30-60 individuals in each petri), +++: very abundant (more than 60 individuals in a petri))

P. fimbriatus, Speocyclops sp., *K. xanthi* and *N. stammeri* were recorded at different rates in 4 season. Species recorded in 3 seasons *C. forficula, C. colurus, E. elongata, L. patella* (summer, autumn, winter), *D. epicharis, L. stenroosi, T. weberi, T. tetractis, A. crassa, Ectinosoma* sp. (summer, autumn, spring), *C. rectangula, E. serrulatus, E. richardi* (Summer, winter, spring). Species recorded in 2 seasons *C. uncinata, E. brachionus, L. bulla, L. furcata, L. papuana, L. salpina, M. laticornis* (summer, autumn), *T. patina, M. aestuarii* (summer, spring), *P. aduncus* (winter, spring), *M. viridis* (summer, winter). *B. quadridentatus* and *R. neptunia* (summer) were recorded in only one season (Table 4).

The species showed differences in plankton and interstitial samples according to their presence. *B. quadridentatus* (2 times in plankton/once in interstitial), *C. forficula* (3/2), *C. gibba* (14/6), *Colurella adriatica* (12/2), *D. epicharis*, (4/1), *E. elongata* (3/2), *E. brachionus* (3/1), *E. dilatata* (9/1), *L. bulla* (6/4), *L. closterocerca* (9/4), *L. furcata* (3 /1), *L. hamata* (7/4), *L. luna* (10/4), *L. papuana* (5/3), *L. stenroosi* (4/2), *Lepadella patella* (6/2), *R. neptunia* (2/1)), *T. weberi* (4/3), *Trichotria tetractis* (6/4), *C. rectangula* (7/3), *M. laticornis* (5/1), *E. serrulatus* (3/2), *M. viridis* (2/1), *M. mehmetadami* (2/1), *M. aestuarii* (3/2) were recorded at different rates in both plankton and interstitial samples throughout the study but they were recorded more in plankton samples. *P. fimbriatus* (4/4) was recorded in equal numbers in plankton and interstitial samples, while *Speocyclops* sp. (3/4), *A. crassa* (1/2), *Ectinosoma* sp. (1/2), *E. richardi* (1/2), *K. xanthi* (1/5) and *N. stammeri* (2/4) were recorded more in interstitial samples (Table 4).

There was a significant positive correlation between the number of zooplankton species and temperature (R^2=0.56), conductivity (R^2=0.50), dissolved oxygen (R^2 = 0.80), and salinity (R^2=0.95) (Table 5). Similarly, a significant positive correlation was observed between the abundance of zooplankton and temperature (R^2=0.80), conductivity (R^2=0.61), dissolved oxygen (R^2=0.98), and salinity (R^2 =0.67) (Table 5).

Table 5. The relationships between zooplankton and water quality parameters

Parameter	Zooplankton species number	Zooplankton abundance
Salinity	R^2 = 0.95	R^2 = 0.67
Temp	R^2 = 0.56	R^2 = 0.80
Con	R^2 = 0.50	R^2 = 0.61
DO	R^2 = 0.80	R^2 = 0.98

Discussion

Salinity was found to be higher (3 ppt) only in the first station compared to the other stations because it was in contact with sea water. Accordingly, the relationship between salinity and the number of zooplankton species and zooplankton abundance was found to be significant. According to Gao et al. (2008), salinity affects the number of individual zooplankton species, which determines the total density of zooplankton. The biomass of zooplankton is largely determined by salinity. Similar to density, higher salt concentrations result in larger zooplankton biomass (Echaniz et al., 2012). Paturej and Gutkowska (2012) discovered a modest positive association between salinity and the number and biomass of zooplankton in the Vistula Lagoon.

Temperature influences the species diversity and density of zooplankton in aquatic ecosystems, which are among the most important environmental parameters controlled by temperature (Herzig, 1987; Sharma et al., 2007). Temperature increases the biological activity in the water, and by accelerating the biochemical reactions, it affects the reproduction, nutrition and metabolic activities of aquatic species (Taş et al., 2010). The abundance of zooplankton was affected by seasonal temperature changes (Rossetti et al., 2009). Water temperature varied between 11.2 °C and 32.4 °C and a positive significant relationship between temperature and zooplankton was observed. Similarly, Dorak (2013) recorded that environmental characteristics, particularly water temperature and nutrients, have a considerable impact on zooplankton composition and abundance, and that high zooplankton abundance is associated with high water temperature.

Conductivity was between 360 and 1646 µS cm^{-1}. Although the electrical conductivity in freshwater varies between 400 and 3000 µS cm^{-1}. High and low conductivity lakes have different zooplankton groups, and species diversity declines as conductivity rises (Tavsanoglu et al., 2015). The conductivity was found to be high in particular streams and during certain times of the year, while being close to the norms (400 µS cm^{-1} -first class waters). Conductivity is important water quality parameters that is significantly correlated with zooplankton abundance and distribution. Therefore, there was a positive correlation zooplankton diversity, abundance and conductivity (Karp-Boss et al., 1996). Determined water quality parameters, for animals in water are observed to be within the normal values.

The species identified in the study are those detected in various inland water studies (lentic and lotic) (Ustaoğlu et al., 1996; Göksu et al., 1997; Ustaoğlu et al., 1997; Saler and Şen, 2001; Bekleyen, 2003; Bozkurt, 2004; Akbulut and Yıldız, 2005; Altındağ et al., 2005; Kaya et al., 2007; İpek and Saler, 2008; Altındağ et al., 2009; Bozkurt and Güven, 2010; Bulut and Saler, 2014; Saler et al., 2015; Ergönül et al., 2015; Güher and Demir, 2018; Kaya and Altındağ, 2009; Jersabek and Bolortsetseg, 2010; İpek Alış and Saler, 2013; Güher and Çolak, 2016).

As in this study, it has been determined that rotifers are the most recorded group among all zooplankton in many studies conducted in rivers (Saunders and Lewis, 1988; Vasquez and Rey, 1989; Kim and Joo, 2000; Göksu et al., 1997; Bozkurt, 2004; Bozkurt and Güven, 2010; Bozkurt and Akın, 2012; Bulut and Saler, 2014). Ruttner-Kolisko (1974) reported that the embryonic development times of rotifer species shortened in parallel with the increase in ambient temperature, and accordingly, they multiplied rapidly in a very short time. The seasonal variation in the streams where this study was conducted showed similarities with other running waters where the zooplankton population is low in cold season and high in hot season (Saunders and Lewis 1988).

According to several studies (José de Paggi 1980; Saunders and Lewis 1988; Vasquez and Rey 1989), the volume and species variety of zooplankton in flowing water varies depending on the discharge regime, turbidity, water quality, and river upstream and downstream.

M. mehmetadami and *K. xanthi,* discovered in this study and recently added to the zooplankton fauna in inland waters of Turkey, were identified for the first time from interstitial samples from Turkey (Karaytuğ et al., 2018; Bruno and Cottarelli, 2015). *K. xanthi* was found for the second time in the Sarıseki stream and reeds (Bozkurt, 2017), and the third time in the well water in the Yayladağı district (Bozkurt, 2022). *N. kosswigi* and *N. stammeri,* which are rarely found in inland waters of Turkey, were found in the Dragon River (Bozkurt, 2017), additionally *N. stammeri* was found in the well waters of Yayladağ district (Bozkurt, 2022). *Speocyclops* found in this study was first record in well waters in Turkey by Bozkurt (2018). *E. richardi* was first found in Sarıseki Stream in Turkey (Bozkurt, 2017). *P. viguieri* was found in Turkey for the first time from Gölbaşı lake (Bozkurt, 2007), second time from Sarıseki stream (Bozkurt, 2017) and third time from Yayladağı well waters (Bozkurt, 2022). *L. brevicornis* was first reported from interstitial samples from Gölkent Lake in Turkey (Bozkurt, 2007).

If we look at the general ecological characteristics of the copepod species reported above; *L. brevicornis* lives in brackish areas of the marine littoral as well as saline and fresh inland waters (Borutsky, 1964). *E. richardi* is cosmopolitan, capable of cold stenothermic and parthenogenetic reproduction (Dole-Olivier et al., 2000), often found in semi-terrestrial habitats, wet moss, seepage and water sources (Rundle et al., 2000). *P. viguieri* is a cosmopolitan species, found in habitats ranging from the bottom sediments of lakes to compost piles, in the hyporheic zone of streams and in the seats of bromeliads. It is most common in semi-terrestrial moist soils, moss and decomposing organic matter (Glatzel and Konigshoff, 2005). *N. kosswigi* is a groundwater species and has been reported from wells and lakes in Turkey (Reid, 2001; Yağcı and Ustaoğlu, 2012). *N. stammeri* is a stygobitic species with generally limited distribution but widely distributed in coastal karst environments (fresh and anchialine waters, wells, caves). *Speocyclops,* a nearly pan-European genus, is a unique morphological, zoogeographical, and ecological unit. From the Pyrenees to the Western Caucasus, species of the genus live in the subterranean waters of the Alpine formation in South Europe. The genus *Metacyclops* is widespread in tropical and temperate regions, most of them have been recorded in different groundwater habitats, such as wells, caves, anchialine habitats (Pesce, 2015). *M. grandispinifer* is one of the 6 species of the genus found in Turkey (Bozkurt, 2021). It is the second report of the species after its first report (Lindberg, 1940) from Turkey.

According to Ceccherelli et al. (1982), *C. perplexa*, an epibenthic harpacticoid copepod, is found in brackish waters. Similarly, the cosmopolitan, coastal, neritic *E. acutifrons* are mainly coastal marine species, but are also common in brackish waters as they can tolerate a wide variety of salinity (Razouls et al., 2009). In a study, *C. perplexa* and *E. acutifrons* were found in the Kızılırmak river mouth (in brackish waters) (Deniz and Gönülol, 2014). In this study, *C. perplexa* and *E. acutifrons* were found only in station 1, which has brackish water characteristics due to the rising sea water from time to time. *Mesochra aestuarii* is characterized as euryhaline species (Remane and Schlieper, 1971) and is a brackish water species frequently seen in fresh water (Lang, 1948; Noodt, 1970; Kunz, 1971). It was reported for the first time in Turkey by Gündüz (1989) from the Bafra Fish Lake.

The genus Ectinosoma has not been reported from Turkish inland waters so far, but has been reported from marine water. A new record for Turkish inland waters, a species belonging to the genus *Ectinosoma,* was detected in station 2, where sea water could not reach.

In general, the species identified in this study were reported to be common and highly tolerant to environmental conditions in many lotic and lentic water studies conducted in Turkey (Bozkurt and Akın 2012; Bozkurt et al., 2018; Bozkurt and Güven 2010; Özdemir Mis et al., 2011; Gaygusuz and Dorak, 2013; Saler et al., 2015; Ustaoğlu, 2004; Ustaoğlu, 2015).

In this case, it can be postulated that the existence of the species in the study areas is closely related to the ecological characteristics and habitat preferences of the species.

Conclusion

The zooplankton fauna of the running water, which were mostly fed by groundwater, surface water and leachate water consists of 43 rotifer, 21 copepod and 6 cladoceran species. A total of 15 rotifer families, 3 cladoceran families and 10 copepod families were recorded. The number of zooplankton species and abundance had significant positive correlation with salinity and dissolved oxygen. *B. quadridentatus, C. adriatica, E. brachionus, L. bulla, L. closterocerca, L. hamata, Lepadella patella, R. neptunia, T. tetractis, Speocyclops* sp. were very abundant in different seasons and lothic systems, while cladocerans and copepod species were much less common in all streams and seasons. Most of the species recorded in this study are considered cosmopolitan.

COMPLIANCE WITH ETHICAL STANDARDS

Authors' Contributions

This paper was produced from master thesis of Figen Can and authors contributed equally to this paper.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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