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A preliminary study on zooplankton fauna of Iskenderun Technical University campus pond and first record of *Pleuroxus wittsteini* Studer, 1878 (Anomopoda, Chydoridae) for Turkish inland waters

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ABSTRACT

A total of 22 species, 16 Rotifera, 4 Cladocera and 2 Copepoda, were identified in the study carried out in the pool located in the Iskenderun Technical University campus. The most species were found in Lecanidae family with 5 species. *Pleuroxus wittsteini* detected in this study is a new record for inland waters of Turkey.

Introduction

Ponds are closed microcosms and are complex systems to assess, as they present great internal complexity. Unlike lakes, ponds, which are small in size and low in depth, are generally built for irrigation, flood protection, water supply (Baxer, 1977) and recreational purposes. Natural and man-made ponds are reported to still represent at least 30% of the global surface area of the available freshwater resource, despite major losses in some countries (The Pond Manifesto, 2008). Potentially, such small water bodies could take on the environmental role of natural ponds and lakes.

Small water reservoirs and shallow lakes are, as group, extremely rich in point of biodiversity (Chmielewski et al., 1997; Williams et al. 2004; Fahd et al., 2009), but they have only recently been recognized as important habitats (Biggs et al., 2005). Compared to pools and ponds, smaller reservoirs are larger and therefore more stable temporarily. On average, it is reported that local species diversity in lentic systems tends to increase from small and temporary reservoirs to larger and more permanent systems (De Bie et al., 2008; Davies et al., 2008).

Ponds create links between existing water habitats and provide ecosystem services such as nutrient retention, hydrological regulation, water supply, wildlife conservation, and research (Oertli et al., 2005). Considering their ecological importance, ponds are exposed to many threats from various human activities (Álvarez-Cobelas et al., 2005; Biggs et al., 2005).

Studies have reported that there is a close relationship between the productivity of the aquatic environment and zooplanktonic organisms, and pollution has negative effects on zooplankton. For example, Dumont (1983) reports that eutrophication and water pollution in general cause changes in species composition of zooplanktonic organisms, and therefore zooplankton studies in aquatic environments are also very important in this respect.

The study was carried out to determine the zooplankton fauna of the pond located in the Iskenderun Technical University campus, fed by groundwater, where various waterfowl and duck species live and used as a recreation area.

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Material and Methods

The distance of the pool to the sea is around 850 m, and the reduced water is reinforced from the underground well located near the pool. The maximum depth of pond was 1.5 m and a surface area was about 1.08 ha. There were reeds and mats on the shoreline of the pool (in contact with water), and there were various above-water and underwater plants in the water.

Zooplankton samples were collected from İskenderun Technical University campus pond (36° 34 ′46 ′′N, 36° 08 ′57 ′′ E) by using a plankton net with 60 µm mesh size. The net was thrown from the pond shore to the interior (about 8-10 meters), pulling it from the surface to the shore, and also collected at different depth. This process was done at least 20 times. Samples were collected in April, May, June and July 2017, and then were replaced into glass jar and fixed with 4% formaldehyde. Dissolved oxygen and water temperature (YSI model 52 oxygen meter), pH (YSI 600 pH meter), and conductivity (YSI model 30 salinometer) were measured directly at the field by means of digital instruments. The zooplankton species identification was done using an Olympus CH40 microscope. To identify the species the works of Ruttner-Kolisko (1974), Koste (1978), Segers (1995), Scourfield and Harding (1966), Smirnov (1974), Negrea (1983), Korinek (1987), Pennak (1989), Borutsky (1964), Dussart (1969), Damian-Georgescu (1970), and Kiefer (1978) were reviewed.

In the study, 12 female individuals from *Pleuroxus wittsteini* specimen were used for diagnosis. After the individuals were placed in a drop of glycerine on the slide, they were examined and a small lamella fracture was placed between the lamella to prevent the organism from being crushed, and diagnosis and extractions were made under the olympus CH40 binocular microscope.

Results

The lowest and highest values of the water quality parameters were determined as follows; the temperature was measured between 17-33°C, dissolved oxygen 7.98-8.50 mg/l, pH 8.50-8.70, electrical conductivity 2140-2413 µS and salinity 1.4-3.2‰.

A total of 22 species were identified in the study, 16 from Rotifera, 4 from Cladocera and 2 from Copepoda. It was determined that the most species of Rotifera (5 species) belong to the Lecanidae family, followed by the Brachionidae (3

Table 1. Species identified in the study and sampling time

Rotifera	Apr. 2017	May 2017	Jun. 2017	Jul. 2017
Brachionidae				
Brachionus angularis Gosse, 1851				+
Brachionus quadridentatus Hermann, 1783	+			+
Keratella cochlearis Gosse, 1851			+	+
Lepadellidae				
Colurella adriatica Ehrenberg, 1831			+	
Lepadella ovalis Müller, 1786	+	+	+	+
Euchlanidae				
Euchlanis meneta Myers,1930	+	+	+	+
Notommatidae				
Eosphora najas Ehrenberg 1830				+
Hexarthridae				
Hexarthra fennica Levander, 1892	+			+
Lecanidae				
Lecane luna (Müller, 1776)	+	+	+	+
Lecane nana (Murray, 1913)				+
Lecane ohioensis (Herrick, 1885)	+	+		+
Lecane papuana (Murray, 1913)				+
Mytilinidae				
Lophocharis salpina Ehrenberg, 1834			+	+
Synchaetidae				
Polyarthra dolichoptera Idelson, 1925	+			
Testudinellidae				
Testudinella patina Hermann, 1783	+		+	
Cladocera				
Daphnidae				
Ceriodaphnia reticulata Jurine, 1820		+	+	+
Daphnia magna Straus, 1820			+	+
Moinidae				
Moina micrura Kurz, 1875				+
Chydoridae				
Coronatella rectangula Sars, 1861	+	+	+	+
Pleuroxus wittsteini Studer, 1878				+
Copepoda				
Cyclopidae				
Megacyclops viridis Jurine, 1820	+	+	+	+
Diaptomidae				
Arctodiaptomus similis Baird, 1859			+	+

species) and the Lepadellidae family (2 species). Other families were represented by one species each. While 2 species belonging to Daphniidae and Chydoridae families were determined, Moinidae family was represented by a single species. Cyclopidae and Diaptomidae families from Copepoda were determined to be represented by one species each (Table 1). *Pleuroxus wittsteini* is reported for the first time in Turkey inland waters (Figure 1).

Short diagnosis

Individuals of *Pleuroxus wittsteini* are dark brown in colour with numerous coarsely-spaced dark lines on shell and partly covering the head (Figure 1A). The rostrum is shorter than the labrum and two head pores are visible in lateral view (Figure 1C). Head shield posteriorly widely rounded, anteriorly produced as a blunt rostrum. Head shield and valves with well-expressed reticulation, prominent under valve surface. All setae of valve ventral margin exactly marginal. Setules on posterior margin of valve exactly marginal. Postabdomen short and wide, strongly narrowing distally, with a widely rounded dorsodistal end, its anal margin clearly longer than preanal margin or postanal margin, anal teeth represented as series of small setules (Figure 1B). The postabdominal claw has a row of setae along the concave margin as well as on the proximal third of the convex margin. Antenna I not reaching tip of rostrum, with a strong basal peg. On antenna II, one apical seta on both exopod and endopod shorter than other two setae. In the description of the *P. wittsteini* species, Smirnov et al. (2006) study was used and it was seen that body structures were compatible with this study.

World Wide Distribution of species; Kerguelen archipelago, Heard, Marion, Prince Edward Islands (Smirnov et al., 2006).

Discussion

The electrical conductivity of natural surface waters varies between 50-1500 µS/cm (Mc Neely et al., 1979). The electrical conductivity of groundwater varies more widely than surface waters. The total concentration of ions contained in underground waters, and therefore the electrical conductivity, depends on the route the waters take up to the surface, the type and solubility of the rocks, the climate, the distance to the sea and the precipitation conditions in the region. Since the seawater conductivity is about 50000 µS/cm, we can say that the electrical conductivity of the pond water (2140-2413 µS) was quite high. Considering

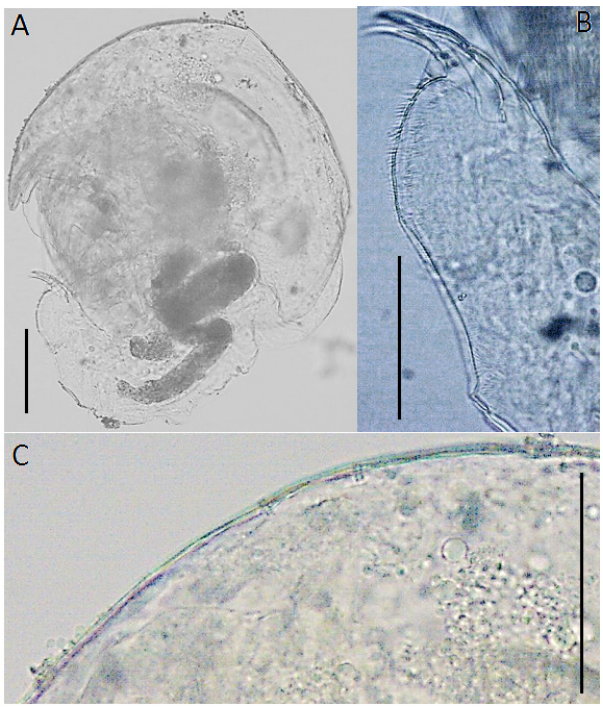

Figure 1. *Pleuroxus wittsteini* **A:** Body, **B:** Postabdomen, **C:** Head pore. Bars: 0.1 mm

Order : Anomopoda Sars, 1865
Family : Chydoridae Stebbing, 1902 emend. Dumont&Silva Briano, 1998
Subfamily : Chydorinae Stebbing, 1902
Genus : Pleuroxus Baird, 1843
P. wittsteini

the characteristics such as conductivity and the distance of the habitats to the sea in the freshwaters where the species was previously found, it is seen that it has similar features to the features of the campus pond where we conducted our study.

Rotifera is the predominant group amongst all zooplankton groups qualitatively and quantitatively in freshwater ecosystem (Saksena, 1987). The result obtained in the study was accordance with results of Saksena (1987). It was reported that almost all rotifer species in the study widespread, common, cosmopolitan (Hutchinson, 1967; Ruttner-Kolisko, 1974; Eldredge and Evenhuis, 2003; Braioni and Gemlini, 1983; Ramdani et al., 2001) and the species were reported from lots of study inland waters of Turkey (Ustaoğlu et al., 2004).

Studies of the diversity of rotifers and other zooplankton have shown that rotifers are ubiquitous in freshwater ecosystems, including sewage ponds (Segers, 2008), and moreover, they are opportunistic in extreme conditions (Gannon and Stremberger, 1978).

The cosmopolitan nature of inhabitants of

freshwaters is also generally known (Byars, 1960). The taxa in the study, *Megacyclops, Daphnia, Ceriodaphnia, Moina, Coronatella, Pleuroxus, Brachionus, Colurella, Euchlanis, Keratella, Polyarthra, Lecane, Lepadella, Lophocharis, Hexarthra* and *Testudinella* are common in Southern inland waters of Turkey (Ustaoğlu, 2004; Ustaoğlu, 2015; Ustaoğlu et al., 2012; Tugyan and Bozkurt, 2019). The zooplankton species composition of the pond has important similarities with those recorded in other freshwater bodies found in the region.

The species detected in the study, *Brachionus quadridentatus, B. angularis, Colurella adriatica, Euchlanis meneta, Eosphora najas, Lecane closterocerca, L. luna, Keratella cochlearis, Polyarthra dolichoptera, Testudinella patina, Moina micrura, Ceriodaphnia reticulata, Coronatella rectangula* and *Megacyclops viridis* were reported as the cosmopolitan species by various researchers (Hutchinson, 1967; Ruttner-Kolisko, 1974; Smirnov, 1974; Braioni and Gemlini, 1983; Koste and Shiel, 1986; Ramdani et al., 2001).

Zooplankton plays an indicator role in determining the degree of eutrophication and water pollution (Sladeck, 1983; Saksena, 1987). Species belonging to the *Brachionus* and *Keratella* genus, which are also seen in eutrophic waters and are indicators of eutrophication (Ruttner-Kolisko, 1974), were found in this study. Rotifers react much faster to environmental changes in their aquatic environment than Cladocera and Copepoda species and are more sensitive indicator organisms to changes in water quality. While Rotifera species are generally more in eutrophic waters, Copepoda species are more intense in oligotrophic waters (Herzig, 1987). Accordingly, *Brachionus angularis, Keratella quadrata, Lecane luna, Daphnia magna, Moina micrura* identified in the study area were reported as having eutrophic characters (Voigt and Koste, 1978; Petrusek, 2002).

It was reported that some of the species in the study, *Colurella adriatica, Hexarthra fennica, Lepadella ovalis, Lecane closterocerca, L. luna, L. nana, Keratella cochlearis, D. magna* and *Moina micrura* tolerate a wide range of salinity (Ruttner-Kolisko, 1974; Herzig and Koste, 1989; Arcifa et al., 1994; De Ridder and Segers, 1997; Baribwegure and Segers, 2001; Pattnaik, 2014). On the other hand *L. papuana* was previously found among estuarine zooplankters (Neumann-Leitão et al., 1992).

Edmondson (1959) has reported that *Moina* is present in the muddy murky waters mostly, and some of its species are distributed in the salty lakes. *Eosphora najas* is a littoral planktonic species (Plewka, 2016), but it is known to occur among bryophytes in streams (Madaliński, 1961) and ponds (De Smet, 1993). Thus, this taxon could be regarded as tolerant to various environmental conditions. *C. adriatica* and *E. meneta* can live in very different extreme environments. *Lecane luna* occurs in abundance in weedy ponds all over the world and is without doubt one of the commonest of all rotifers (Harring and Myers, 1926). *Lecane papuana* is considered to be a warm stenothermal species (Segers, 1995) and it behaves as a high-temperature thermal specialist. *Lophocharis salpina*, periphytic species, occasionally occurs in plankton. It inhabits preferentially alkaline waterbodies. It also may be found in dystrophic environments (Velasco, 1990). *Polyarthra dolichoptera* is a cold-stenothermal species (Koste, 1978; Virro et al., 2009) and is described as tolerating a wide range of dissolved oxygen values (Berzins and Pejler, 1989a), conductivity and trophic conditions (Berzins and Pejler, 1989b). Euryhaline *Testudinella patina* is common in freshwaters rich in submerged vegetation, but also regularly reported from the marine littoral, and brackish and inland saline waters (De Ridder and Segers, 1997; Fontaneto et al., 2006). *Ceriodaphnia reticulata* is quite widespread and it occurs in floodplains, ponds, ponds along roads, temporary reservoirs that do not dry out for a long time and are more successful at higher temperatures (Hudec, 1993). *Daphnia* populations can be found in a range of water bodies, from huge lakes down to very small temporary pools, such as rock pools and vernal pools (seasonally flooded depressions). It can be found in fresh and brackish water bodies. It is widespread in the Northern Hemisphere and it tolerates low oxygen conditions, high pH, wide ranges of salinity (8 ppt) and temperature (Hebert, 1978). *M. micrura* is rarely found inhabiting the great lakes (Balcer et al., 1984), it is inhabit temporary pools that are often highly eutrophic and have shallow depth (Crosetti and Margaritora, 1987), relatively turbid lakes (Jana and Pal, 1985; Hart, 1990). According to Nandini et al. (2002), *Coronatella rectangula* (former *A. rectangula* Sars, 1861) is generally found associated with macrophytes of the littoral region. In the water bodies where *C. rectangula* were found, the water is well oxygenated and the pH tended to be acidic (França and Stehmann, 2004). *C. rectangula* for example, are common, widespread, and build significant populations. *Pleuroxus wittsteni* has so far been reported from

freshwaters on the Kerguelen archipelago, Heard, Marion, Prince Edward islands, which are only found in the south Indian Ocean in the world. The available data are thought to be insufficient to make a decision about the habitats and water quality characteristics in the aquatic ecosystem. However, the most important data are that the freshwater environments in which they are located are close to the sea (75-2100 m), the relatively high mineral content and high conductivity of the water, and the plant richness of the waters (Frey, 1991). The fact that the conductivity is relatively high (representing the high amount of dissolved matter), being close to the sea (approximately 850 m) and rich in plants, strengthens the presence of this species in the campus pond where the study was conducted. *Megacyclops viridis* is a common littoral copepod. It has a scattered distribution and occurs from sea level to 1396 m. It occurs in water bodies of all sizes, seems to favour the species. *M. viridis* is tolerant to pH and occurs in both electrolyte poor and electrolyte rich water, being most common in the latter. *M. viridis* is often associated with the presence of macrophytes and can tolerate moderately eutrophic water (Pesce and Maggi, 1981; Einsle, 1988; Berzins and Bertilsson, 1990; Hansen and Jeppesen, 1992; Wolfram et al., 1999; Baranya et al., 2004). *Arctodiaptomus (Arctodiaptomus) similis* inhabits both permanent water bodies and temporary rainpools, prefers waters with low salinity, temperature ranges between 4 to 30°C, and it is a widespread species (Kiefer, 1978; Reddy, 1994).

Visually, it can be said that the pond has a meso-eutrophic character in terms of plant density, water colour and determined zooplankton species (especially *Lecane* and *Brachionus*). It is seen that most of the species identified in the study are suitable for their ecological characteristics to be found in the pond where the study was conducted. Therefore, there is no doubt about their presence here. In addition, considering the islands in the Atlantic where *P. wittsteini* has been reported so far, it is seen that they live in brackish inland waters near the seas.

Conclusion

Our study is to determine the zooplankton fauna of the pond located in Iskenderun Technical University campus. It has been determined that the water of the pond fed by groundwater is slightly brackish (in terms of the conductivity value it contains), and the species identified are zooplankton species that can withstand brackish water. In addition, *Pleuroxus wittsteini* from Cladocera, was determined to be a new record for inland waters of Turkey.

COMPLIANCE WITH ETHICAL STANDARDS

Conflict of Interest

The author declare that there is no conflict of interest.

Ethical Approval

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

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