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Investigation of zooplankton fauna in water wells of Kuyubeli village (Adana, Turkey) with the first record of the genus *Speocyclops* Kiefer, 1937 (Copepoda, Cyclopoida, Cyclopidae) for Turkish inland waters

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Abstract: Zooplankton samples were collected from water wells in Kuyubeli village (Kozan, Adana, Turkey). A total of 24 zooplanktonic species were identified, including 13 rotifers, 9 copepods, and 2 cladocerans. The genus *Speocyclops* was reported for the first time from Turkish inland waters.

Key words: *Speocyclops*, zooplankton, water wells, Kozan

Well water is used primarily as a source of drinking water and mostly for irrigation by the vast majority of the rural population in Turkey. Therefore, villagers use well water for all their needs as a water source. These wells have been installed in sampling areas at various depths, depending on the availability and the level of groundwater.

Freshwater zooplankton have colonized many different subterranean habitats. Some zooplanktonic organisms such as copepods may be good indicators of habitat heterogeneity. Zooplankton may play significant roles in groundwater food webs and ecosystems, but their ecological functions in ground water are imperfectly known (Gibert and Deharveng, 2002).

Cyclopoid copepods constitute an important part of the groundwater biodiversity in karstic habitats, and they live in planktonic or epibenthic and hyperbenthic habitats in underground reservoirs.

The pan-European *Speocyclops* Kiefer, 1937 represents a different morphological, ecological, and zoogeographical unit. Species of the genus, except the widespread *S. demetiensis* Scourfield, 1932, inhabit subterranean waters in South Europe from the Pyrenees to the Western Caucasus. At present, the genus contains about 40 named species and subspecies (Monchenko, 1986, 2003; Dussart and Defaye, 1985, 2006).

Cyclopoid copepods have the highest richness with 65 species in the inland waters of Turkey compared to calanoid and harpacticoid copepods (Ustaoglu, 2015).

In this paper a new report of *Speocyclops* sp. is given from subterranean waters of the Mediterranean region of Turkey, and zooplankton species in wells are determined. *Speocyclops*, which has been reported from several sites of Europe and from Madeira Island to date, is reported for the first time in Turkey.

Zooplankton samples were collected by vertical hauls of a standard net (60 µm mesh size) from 8 water wells in the village of Kuyubeli in Kozan, Adana Province. A metal weight of 0.5 kg was attached to the collector, the net was lowered to the bottom of the well, and the water was mixed by shaking. Thus, the water became turbid and zooplankton present in the benthic layers were mixed with water. Then the net was pulled upwards and 10 replicates were made for each well. Sampling coordinates and dates are given in Table 1.

The depth of the water wells are 5, 6, 6.5, 7, 7, 7.5, 8, and 9 m from the surface to the bottom and the water depth is 4, 4.5, 4, 5.5, 5, 5, 6, and 7 m according to sampling time, respectively. The widths of the wells are 1, 1.2, 1.4, 1.7, 1.8, 1.9, 2, and 2 m, respectively. After sampling, zooplankton were fixed and preserved in 4% formaldehyde. Zooplankton samples were examined in a distilled water and glycerol mixture. Specimens of *Speocyclops* sp. were mounted on microscope slides and covered with a coverslip.

Copepod measurements was made using an Olympus microscope (CH40) with micrometric ocular. Body lengths were measured from the top of the rostrum to the posterior edge of the caudal rami. The species were

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Table 1. Sampling sites coordinates and sampling dates.

Sampling points	Coordinates	Sampling dates
1	37°41'01.01"N, 35°59'09.18"E	17.08.2006, 24.10.2006, 17.8.2007, 12.04.2015
2	37°41'05.87"N, 35°59'08.48"E	12.04.2015, 02.12.2015, 10.02.2016, 03.04.2017
3	37°41'09.62"N, 35°59'06.70"E	26.8.2006, 17.8.2007, 12.04.2015
4	37°41'02.82"N, 35°59'10.97"E	12.04.2015
5	37°41'02.63"N, 35°59'12.85"E	12.04.2015
6	37°41'07.41"N, 35°58'50.43"E	10.02.2016
7	37°41'02.38"N, 35°58'56.41"E	10.02.2016
8	37°41'31.22"N, 35°59'41.42"E	15.08.2017

identified with the aid of Monchenko (2010), Galassi and De Laurentiis (2004), Segers (1995), Negrea (1983), and Dussart (1969).

In this study, 13 species of rotifers, 9 species of copepods, and 2 species of cladoceran were identified in the water wells (Table 2).

T. patina was found in all water wells at all sampling dates but some other species, including *Heterolepadella ehrenbergi*, *Lecane clostercerca*, *Lepadella patella*, *Keratella cochlearis*, *K. quadrata*, *K. tecta*, *Trichotria tetractis*, *Chydorus sphaericus*, *Bryocamptus minutus*, *Canthocamptus microstaphylinus*, and *Nitocrella kosswigi*, were found in different water wells only once (Table 2).

Although the abundance of zooplankton was not determined numerically, it was found to be considerably less according to visual observation under the microscope. The most abundant species were *Tropocyclops prasinus*, *Speocyclops* sp., and *N. kosswigi*, followed by *A. crassa*, *T. patina*, *D. bicuspidatus*, and *L. clostercerca*. Moreover, it was observed that other species were found in very small quantities.

Female body length of *Speocyclops* sp. specimens was 630–880 µm (mean = 763 µm; n = 10). Body somewhat compact in dorsal view with irregular formication. Prosome wider than urosome and prosome:urosoma ratio about 1.40. Copulatory pore placed on distal third of genital double somite. Anal somite ventrally ornamented with strong spinules; anal operculum ovate, with irregularly toothed edge. Caudal rami slightly longer than wide, with 6 bipinnate setae; hind margin with spinules ventrally.

Male body length including rostrum to the posterior of the caudal rami: 580–690 µm (mean = 633 µm; n = 6). Prosome: urosoma ratio 1.64, and urosoma with six somites.

Groundwater biodiversity is higher than previously thought. To date, this kind of biodiversity has been disregarded for several reasons, and limited knowledge of the groundwater ecosystems and related fauna prevents

any kind of further elaboration of data (Galassi and De Laurentiis, 2004). Copepod species constitute a significant part of groundwaters that contain poor communities in terms of species richness and abundance (Galassi 2001).

Almost all species detected in this study are widely distributed and can live in very different extreme environments (Hutchinson, 1967; Ruttner-Kolisko, 1974; Margalef et al., 1976; Braioni and Gelmini, 1983; Koste and Shiel, 1986, 1987; Ramdani et al., 2001). It has been reported that *Lecane* is generally found in littoral and benthic regions and is not a migratory genus (Ruttner-Kolisko, 1974). *L. bulla* prefers alkaline waters (Pejler, 1962; Koste, 1978). *Diacyclops bicuspidatus* and *D. bisetosus* are widely distributed in cave and groundwaters, and they are common copepods in zooplankton samples. Benthic *B. (B.) minutus* and *A. crassa* inhabit both large and small waterbodies (Borutskii, 1952).

It was observed that the findings were coherent with the literature knowledge and the collected species were generally durable and appear in many areas.

The correct identification of the *Speocyclops* species cannot be made for several reasons. However, the wrong previous species descriptions and in many cases the limited number of specimens under study have been the main reasons why species identification is rather difficult. The genus *Speocyclops* contains 40 named species and subspecies (Dussart and Defaye, 1985; Pandourski, 1992) but very little is known about the ecology of this genus, except for its interesting adaptations to a subterranean style of life. An almost pan-European genus, *Speocyclops* represents a distinct morphological, zoogeographical, and ecological unit. Species of the genus inhabit subterranean waters of the Alpine formation in South Europe from the Pyrenees to the Western Caucasus.

According to Fiers (2005) this taxon is clearly in urgent need of revision based on as much material as possible. Commonly, the morphology of leg 5, the presence or absence of a distinct remnant of a suture subdividing the

Table 2. Zooplankton species found during the study.

Sampling stations								
Rotifera	1	2	3	4	5	6	7	8
<i>Heterolepadella ehrenbergi</i> (Perty, 1850)					+			
<i>Lecane bulla</i> (Gosse, 1886)		+						
<i>L. closteroerca</i> (Schmarda, 1859)		+						
<i>L. lunaris</i> (Ehrenberg, 1832)	+	+	+					
<i>Lepadella patella</i> (Müller, 1773)								+
<i>Keratella cochlearis</i> (Gosse, 1851)			+					
<i>K. quadrata</i> (Müller, 1786)		+						
<i>K. tecta</i> (Gosse, 1851)			+					
<i>Colurella adriatica</i> Ehrenberg, 1831		+				+		
<i>C. colurus</i> (Ehrenberg, 1830)	+				+			
<i>C. uncinata</i> (Müller, 1773)	+				+			
<i>Testudinella patina</i> (Hermann, 1783)	+	+	+	+	+	+	+	+
<i>Trichotria tetractis</i> (Ehrenberg, 1830)		+						
Cladocera								
<i>Chydorus sphaericus</i> (Müller, 1776)		+						
<i>Pleuroxus aduncus</i> (Jurine, 1820)	+	+	+	+	+			
Copepoda								
<i>Speocyclops</i> sp.		+						
<i>Diacyclops bicuspidatus</i> (Claus, 1857)	+	+	+	+	+			+
<i>D. bisetosus</i> (Rehberg, 1880)		+		+				
<i>Tropocyclops prasinus</i> (Fischer, 1860)	+	+	+		+	+	+	
<i>Paracyclops fimbriatus</i> (Fischer, 1853)	+		+	+				+
<i>Attheyella crassa</i> (Sars, 1863)		+	+	+				+
<i>Bryocamptus minutus</i> (Claus, 1863)		+						
<i>Canthocamptus microstaphylinus</i> Wolf, 1905	+							
<i>Nitocrella kosswigi</i> Noodt, 1954		+						

genital double somite, and the nature of the elements on vestigial leg 6 are features used to separate groups among the several species and subspecies. The shape of the anal operculum, the proportional lengths of the setae on the caudal rami (III and VI), the setal complement of the legs, and the length of the terminal endopodal spine of leg 4

are considered as key features to identify the species and subspecies constituting the different groups.

In accordance with the ecological characteristics of the taxon, it prefers groundwaters, as previously reported, and it was found in Turkish groundwaters for the first time during the present research in Turkey.

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