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RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

COMPOSITION AND VERTICAL DISTRIBUTION OF ROTIFERA IN ASLANTAS DAM LAKE (OSMANIYE-TURKEY)

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Abstract: Rotifera composition and vertical distribution in Aslantas Dam Lake was studied from April 2001 to March 2002. It was established that the rotifera were represented by 33 species and 2 subspecies in the lake. Total average density of the rotifera was found to be 255883 Rotifer/m^3. Species such as *Keratella cochlearis cochlearis*, *K. cochlearis tecta*, *Polyarthra dolichoptera*, *Trichocerca capucina* and *Asplanchna priodonta* were present througout the year. The analysis for the determination of vertical distribution of Rotifera showed that the most abundant species at surface and below surface was *P. dolichoptera* with 34.59%, and *K. cochlearis cochlearis* with 29.29%, respectively. Rotifera had the highest density at 5 m in the lake. In addition, 63.58% of total Rotifera was observed in photic zone while the rest (36.42%) was collected from aphotic zone. Chlorophyll *a* measurement of the dam lake showed that the average montly values were 31.44 mg/m^3 at the surface and 20.13 mg/m^3 below the surface. A vertical increase at the value of chlorophyll *a* was observed from the surface to 7.5 m. Gradual decrease at the value was recorded exceeding the depth of 7.5 m.

Keywords: Aslantas Dam Lake, Rotifera, Chlorophyll *a*

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Introduction

It is a well-established fact that phytoplankton is the base of food chain pyramid in the aquatic environments such as lakes. Zooplankton, following phytoplankton, is the second most important ring of the pyramid of aquatic ecosystems for energy conversion and as food resources. Therefore the importance of zooplankton for fish production and fisheries is obvious. At the same time, many scientists indicated that certain species of rotifers are indicators showing water quality, pollution and eutrophication. (Berzins, 1987; Mikschi, 1993; Saksena, 1987; Sharma, 1983).

This paper presents an analysis of rotifer abundance in Aslantas Dam Lake which is one of the most important freshwater resources of south eastern Mediterranean region of Turkey. There have been no previous rotifer studies undertaken for this lake. The dam was established over the River Ceyhan at 45 km up from Mediterranean Sea for flood prevention, irrigation and hydro electric energy production in 1985. The dam is situated 146 m above the sea level and covers an area of 6.050 ha. Maximum measurements of width and length are 6 km and 16 km, respectively, and the deepest place in the lake measures 93 m (DSİ, 1966).

Besides agriculture, fish such as *Cyprinus carpio, Silurus glanis, Capoeta* sp., *Barbus* sp., *Leiciscus cephalus* and *Alburnus orentis* are providing an important economical benefit for the local people although the dam was built for irrigation purposes DSİ, 2000).

Materials and Methods

The abundance of rotifer fauna in Aslantas Dam Lake was observed between March 2001 and April 2002 using 5 stations for sampling (Figure 1). Sampling was made in monthly intervals except December due to bad weather conditions. Besides, dissolved oxygen analyses of water in April and May were not recorded caused by oxygen meter malfunction.

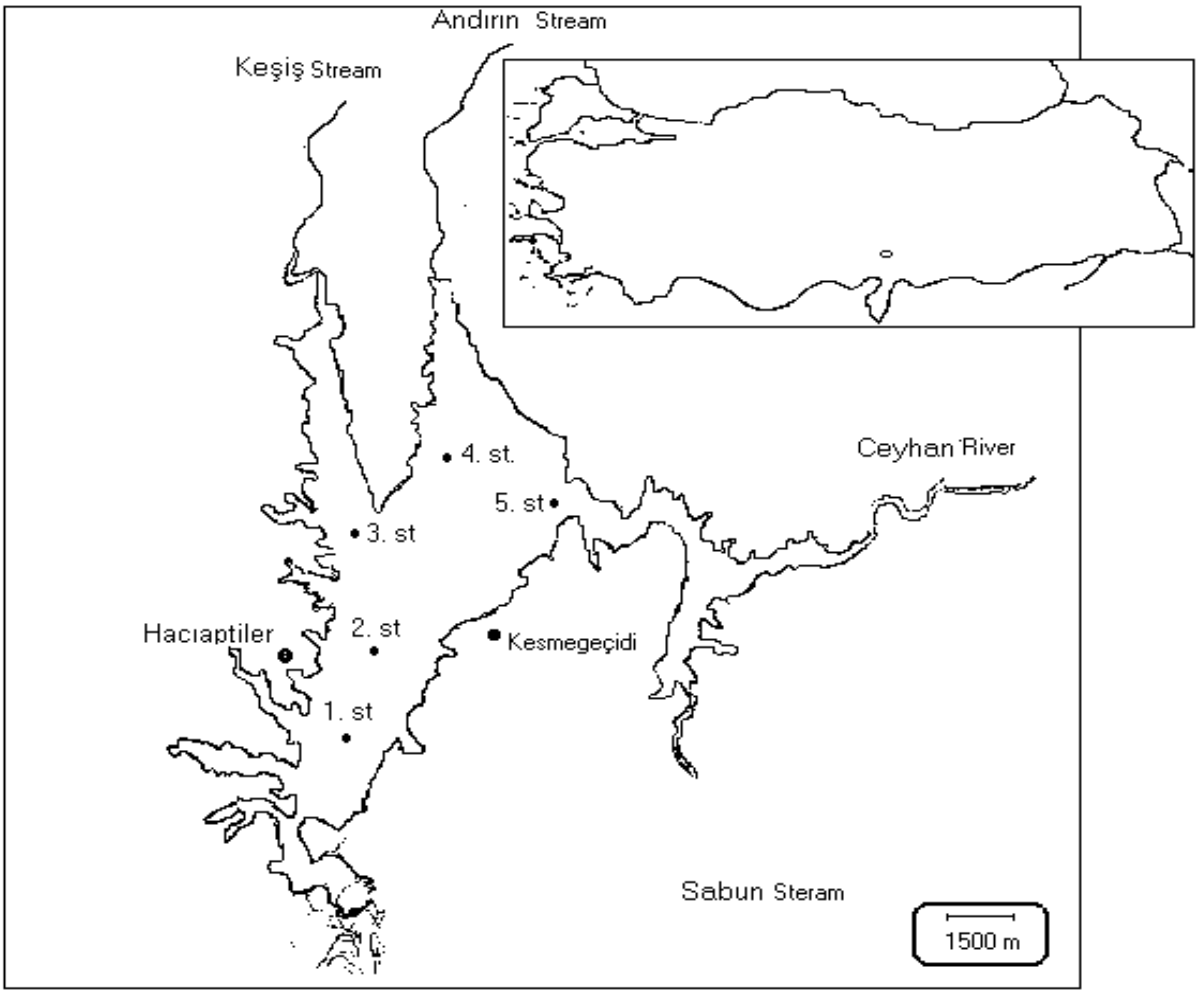

Figure 1. Stations in Aslantaş Dam Lake

Rotifer samples were collected using horizontal plankton net with 60 µm mesh, 1 m length and 30 cm in diameter, and standard Hydrobiyos brand vertical plankton net with 60 µm mesh, and the samples were collected from the surface and different depths in all stations. Water sampling was made using Nansen bottle and the samples were taken from the surface in all stations except Station 1 and Station 2, where sampling was extended to 50 m depth by taking samples from 0.0-1.0-2.5-5.0-7.5-10.0-15.0-20.0-30.0-40.0-50.0 m depths.

Parameters such as dissolved oxygen (DO), temperature, pH, light penetration measurements were recorded during sampling time at study area. Additionally, the depth of photic zone (light penetration zone) at stations 1 and 2 was determined by multiplying the depth of Secchi disk with 2.7 (Cole, 1983; Moss, 1988). Chlorophyll-*a* was analyzed using the method described by APHA, (1995).

The samples, collected with nets and preserved in 4% formaldehyde, were used for qualitative analyses (classification) of rotifer (Dussart, 1969; Voigt and Koste, 1978; Stemberger, 1979; Tsalolikhin, 1994; Tsalolikhin, 1995). Quantitative analyses was carried out following filtration of 5 L water trough 60 µm meshes and preserving the results in 4% formaldehyde.

Results and Discussion

The analyses and observations revealed the following results for physico-chemical parameters shown in Table 1.

Table 1. Mean values of physico-chemical parameters in Aslantas Dam Lake

	Surface						Below Surface			
Months	**T (°C)**	**DO (mgL^{-})**	**pH**	**Chl-a (mgm^{-3})**	**Sechi (m)**	**Photic z. (m)**	**T (°C)**	**DO (mgL^{-})**	**pH**	**Chl-a (mgm^{-3})**
Apr	19.54	-	7.87	48.03	2.40	6.48	17.88	-	7.82	47.37
May	24.90	-	8.12	31.67	2.25	6.08	19.77	-	8.10	45.11
Jun	27.92	8.89	8.04	10.51	2.41	6.50	21.43	7.77	7.88	16.30
Jul	30.46	8.13	8.09	8.16	2.92	7.88	23.39	7.38	7.94	13.49
Aug	30.92	8.01	7.81	9.93	3.83	10.35	24.26	7.48	7.68	10.47
Sept	28.32	9.14	8.18	12.49	3.00	8.10	23.61	8.47	8.15	14.75
Oct	25.00	8.51	8.35	19.85	2.75	7.42	23.00	8.09	8.13	12.62
Nov	18.20	8.77	8.08	24.78	3.02	8.16	17.50	8.46	8.97	20.02
Jan	11.04	7.91	8.09	7.26	3.68	9.94	11.97	7.37	8.11	10.22
Feb	12.80	9.48	7.90	121.79	2.64	7.12	13.01	8.31	7.81	21.23
Mar	17.84	9.15	7.79	51.37	2.75	7.42	13.03	7.83	7.87	9.81
Mean	**22.45**	**8.66**	**8.03**	**31.44**	**2.49**	**7.77**	**18.98**	**7.91**	**8.04**	**20.13**

Maximum temperatures were measured in August as 30.92ºC, whereas minimum temperatures were reached in January as 11.04ºC.

The level of DO was maximum (9.48 mgL^{-1}) in February and minimum (7.37 mgL^{-1}) in January. The highest pH was 8.97 in November while it was the lowest with 7.68 in August.

Chlorophyll *a* at surface reached the highest level with 121,79 mgm^{-3} in February, and the level found out to be the lowest in January with 7.26 mgm^{-3}.

The last parameter, light penetration found to be maximum in August (3.83 m) and minimum in May (2.25 m). Consequently, the range of photic zone was determined to be the largest in August it was determined that the range of photic zone extended to maximum 10.35 m in August and minimum 6.08m in May. Additionally, vertical average values physico-chemical parameters was presented.

The maximum values of the parameters were observed in different depth i.e. temperature (22.40°C) at 1 m, DO (8.58 mgL^{-1}) at surface, pH (8.07) at 5 m, and chlorophyll *a* (34.51 mgm^{-3}) at 7.5 m. However the minimum values were observed at the depths below 30 m, It was 12.10°C at 35 m, 6.01 mgL^{-1} at 32 m, 7.59 at 50 m and 2.22 mgm^{-3} at 32 m, respectively (Table 2).

Taxonomy

As result of this study, it was determined that rotifers in Aslantas Dam Lake are represented with 33 species and 2 subspecies (Table 3). They belong to 15 families in which the number of genus is 21. Determined fauna is listed below according to classification by Wallace and Snell (1991).

Monthly distribution

The monthly presence of determined rotifers at surface and below surface was tabulated in Table 4.

Some species such as *K. cochlearis cochlearis*, *Polyarthra dolichoptera*, *Asplanchna priodonta* and *Trichocerca capucina* were present in the lake throughout the year. Some others such as *K. cochlearis tecta*, *Trichocerca similis*, *Collotheca pelagica*, *Synchaeta pectinata*, *C. gibba* were observed most of the year. The rest of the representatives of Rotifera were observed for a period of 6 month or less. It was also determined that some species showed tendency to live at surface, for example, *Lepadella ovalis*, *Lecane luna*, *L. stenroosi*, *L. lunaris*, *L. Bulla*, *Cephalodella gibba*, *Euchlanis dilatata*, *Scaridium longicaudum*, *Trichotria tetractis*, *Brachionus angularis*, *B. calyciflorus*, *Colurella adriatica* and *Kellicottia longispina*. The species living below the surface only was *Keratella quadrata*.

The monthly distribution of total Rotifera has been shown in Figure 2. The figure shows that rotifer abundance was the most at surface in August whereas it was March below surface. Rotifers were at the least abundant level in May both surface and below surface.

Table 2. Mean vertical values of physico-chemical parameters of all stations

Depths (m)	**T (^{o}C)**	**DO (mgL^{-})**	pH	**Chl-a (mgm^{-3})**
0.0	22.39	8.58	7.98	17.31
1.0	22.40	8.40	7.99	19.87
2.5	21.76	8.35	8.05	23.03
5.0	21.38	8.24	8.07	26.85
7.5	20.54	8.10	8.06	34.51
10.0	19.53	7.90	7.99	29.00
15.0	17.72	7.94	7.92	21.50
20.0	15.87	7.55	7.88	10.48
30.0	14.25	7.15	7.83	8.86
32.0	15.05	6.01	7.97	2.22
33.0	15.42	6.71	7.69	3.99
35.0	12.10	6.62	7.69	9.33
40.0	14.51	6.43	7.83	15.73
50.0	13.25	6.25	7.59	2.30

Table 3. Systematic of Rotifera

Phyllum : Rotifera	
Classis : Monogononta	
Ordo : Ploimida	
Familia : Brachionidae	*Brachionus angularis* (Gosse, 1851) *B. calyciflorus* (Pallas, 1766) *Keratella valga* (Ehrenberg, 1834) *K. quadrata* (O.F.Müller, 1786) *K. cochlearis cochlearis* (Gosse, 1851) *K. cochlearis tecta* (Lauterborn, 1900) *Notholca squamula* (O.F.Müller, 1786) *Kellicottia longispina* (Kellikott, 1879)
Familia : Trichotriidae	*Trichotria tetractis* (Ehrenberg, 1830)
Familia : Euchlanidae	*Euchlanis dilatata* (Ehrenberg, 1832)
Familia : Colurellidae	*Lepadella ovalis* (O.F.Müller, 1786) *Colurella adriatica* (Ehrenberg, 1831)
Familia : Lecanidae	*Lecane luna* (O.F.Müller, 1776) *L. bulla* (Gosse, 1886) *L. stenroosi* (Meissn) *L. lunaris* (Ehrenberg, 1832)
Familia : Asplanchnidae	*Asplanchna sieboldi* (Leydig, 1854) *A. priodonta* (Gosse, 1850)
Familia : Synchaetidae	*Synchaeta pectinata* (Ehrenberg, 1832) *Polyarthra dolichoptera* (Idelson, 1925)
Familia : Notommatidae	*Cephalodella gibba* (Ehrenberg, 1838) *Scaridium longicaudum* (O.F.Müller, 1786)
Familia : Trichocercidae	*Trichocerca similis* (Wierzejski) *T. capucina* (Wierzejski –Zacharias) *T. rattus* (O.F.Müller)
Familia : Gastropodidae	*Ascomorpha ovalis* (Bergendahl, 1892)
Ordo : Flosculariacea	
Familia : Testudinellidae	*Pompholyx sulcata* Hudson, 1885
Familia : Filinidae	*Filinia terminalis* (Plate, 1886) *F. longiseta* (Ehrenberg, 1834)
Familia :Hexarthridae	*Hexarthra oxyuris* (Sernov, 1903) *H. intermedia* (Wiszniewski, 1929)
Ordo : Collothecacea	
Familia : Collothecidae	*Collotheca pelagica* (Rousselet, 1893) *C. mutabilis* (Hudson, 1885) *C. ornata* (Ehrenberg, 1832)
Classis : Bdelloidea Ordo : Bdelloida	
Familia : Philodinidae	*Rotaria neptunia* (Ehrenberg, 1832)

Table 4. Monthly distribution of Rotifera species in Aslantas Dam Lake

ROTİFERA	Ap	Ma	Ju	Ju	Au	Se	Oc	No	Ja	Fe	Ma
Keratella valga					+*	+*	+*	+*			
K. quadrata							*	*	*	*	*
K. cochlearis cochlearis	+*	+*	+*	*	*	*	+*	+*	+*	+*	+*
K. cochlearis tecta		+*	+*	*	*	+*	+*	+*	+*	+	+*
Polyarthra dolichoptera	+*	+*	+*	+*	+*	+*	+*	+*	+*	+*	+*
Lepadella ovalis	+	+						+		+	+
Trichocerca similis	+*			+*	*	+	+*	+*	*	+*	+*
T. capucina	+*	+*	+*	*	+*	+*	*	+*	+*	+*	+*
T. rattus				*			+*	+*			
Collotheca pelagica	+*			*	*	+*	+*	+	+	*	
C. mutabilis				*	+*	+*	+*	+*			
C. ornata					+*	*					
Ascomorpha ovalis	+*	+*	+*	+*	+*	+*	+*				
Pompholyx sulcata	+*	*	*	*				+			
Asplanchna sieboldi	*		*	*	+			+*	*		
A. priodonta	*	+*	*	+*	+*	+	+	+*	+*	*	+*
Synchaeta pectinata	+*				+*		+*	+*	+*	+*	+*
Filinia terminalis	*						+*				
F. longiseta							+*	*			*
Cephalodella gibba	+	+	+					+	+	+	+
Lecane luna							+				
L. bulla							+	+			
L. stenroosi											+
L. lunaris							+				
Euchlanis dilatata	+	+				+		+			+
Scaridium longicaudum	+	+									
Notholca squamula	+							+	+	+	+*
Trichotria tetractis	+	+	+					+	+		+
Brachionus angularis								+			
B. calyciflorus							+				
Rotaria neptunia		*			+*	*			*	+*	+*
Hexarthra oxyuris			+		+*		+	+			
H. intermedia			+*					*			
Colurella adriatica								+			+
Kellicottia longispina				+							

+ : Species observed at surface; * : Species observed below surface

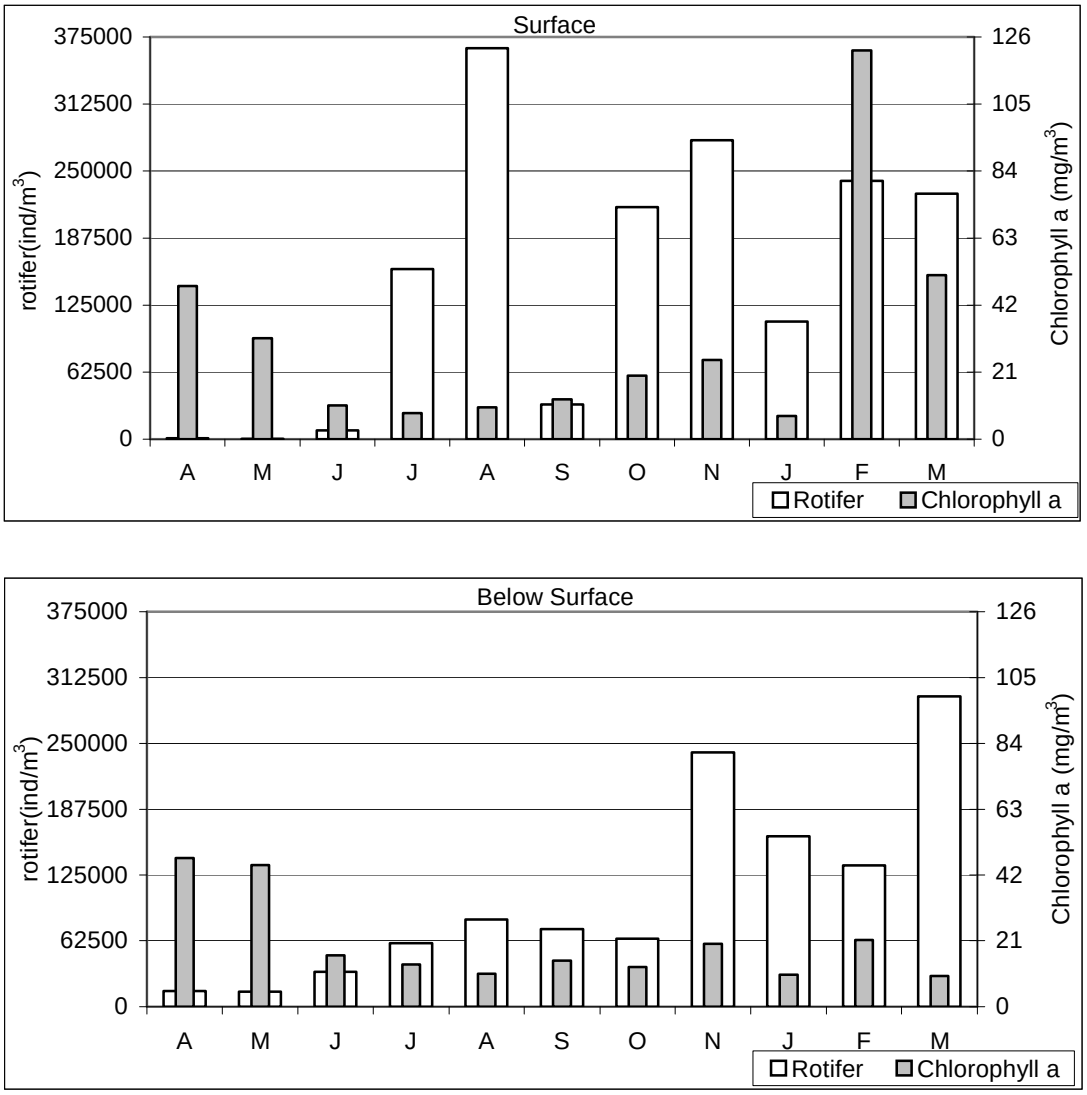

Figure 2. Monthly distribution of total Rotifera and chlorophyll a (surface and below surface)

Vertical distribution

Vertical distribution of total Rotifera has shown in Figure 3. Rotifera were mainly distributed between 2.5 and 10 m. It was found out that the number of total Rotifera increased up to 5 m. There was a constant decrease up to 33 m from 5 m onwards. The number of total Rotifera was the least at 50 m.

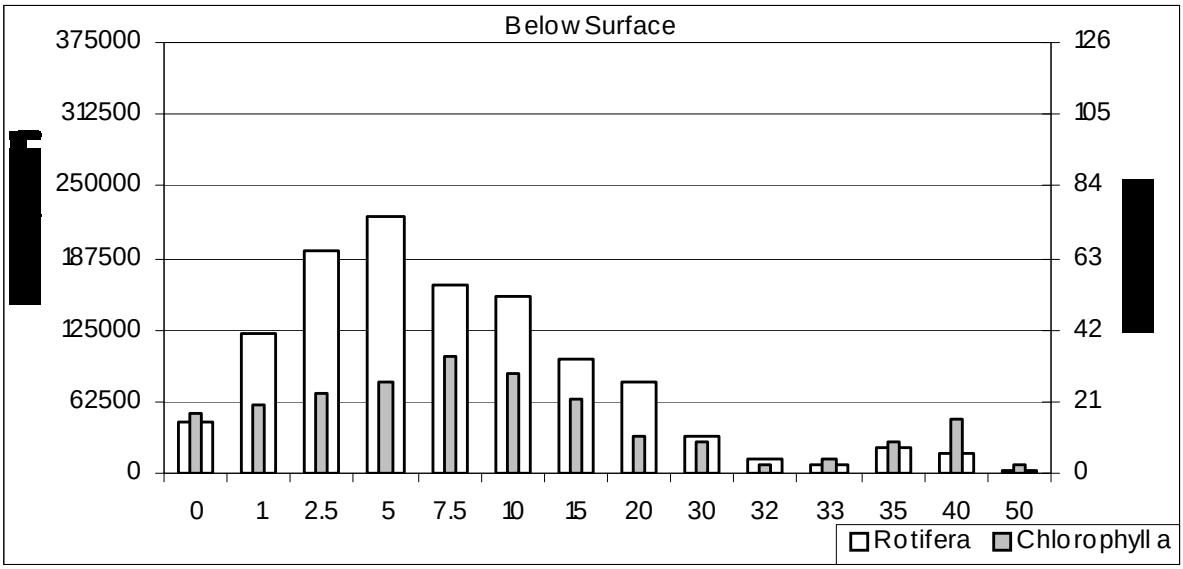

Figure 3. Vertical distribution of total Rotifera and chlorophyll a

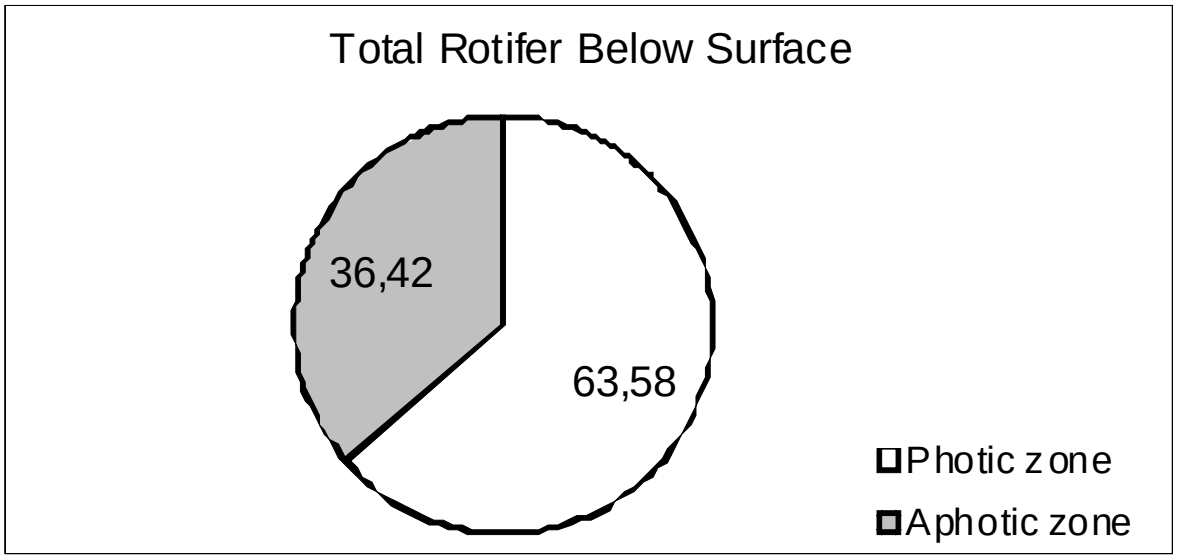

Figure 4. Distribution of Rotifera in the light zones (%)

Vertical distribution of species is such; the most abundant depth (5 m) occupied mostly by *K. cochlearis cochlearis* (102458 ind.m^{-3}) and *P. dolichoptera* (62706 ind.m^{-3}). Main species of the least abundant depth (50 m) were *K. cochlearis tecta*, *T. capucina* and *Ascomorpha ovalis* with a represantation number of 1901 ind m^{-3}, 1098 ind m^{-3} and 394 ind m^{-3}, respectively.

Light dependent distribution showed that 63.58% of Rotifera prefered to live in photic zone and remaining 36.42% was collected from aphotic zone (Figure 4).

Vertical Distribution of rotifer Species has shown in Table 5. The most abundant species, *K. cochlearis cochlearis* (102458 ind m^{-3}) and *P.*

dolichoptera (62706 ind m^{-3}), were commonly found at 5 m depth.

Table 5. Mean vertical values of rotifer species (indm^{-3}) in Aslantas Dam Lake

	Depths (m)													
	0	1	2.5	5	7.5	10	15	20	30	32	33	35	40	50
ROTİFERA														
Keratella valga	736	2034	3992	1555	778	694	458	375	286					
K. quadrata		64				109	108		68			226		
K.cochlearis cochlearis	4802	31151	84747	102458	72981	66816	24161	25763	10259	4437		13396	8582	
K. cochlearis tecta	8191	14283	17089	25099	18637	15897	17819	23435	2485	3500			992	1901
Polyarthra dolichoptera	13625	43217	54890	62706	41390	45442	42928	18977	11503	4090	5312	4729	3942	
Trichocerca similis	185	142	1558	2438	2998	1921	1951	910	403		547	299	162	
T. capucina	234	878	1605	2740	6194	5253	3103	1893	659				1714	1098
T. rattus	58	104	150	194	194	147	101	149	62					
Collotheca pelagica	63	105	245	200	199			64						
C. mutabilis	2444	4236	6463	3785	4166	2162	1175	502	687		566	564		
C. ornata			108											
Ascomorpha ovalis	656	6249	6424	7015	6142	5057	995	1363	386		399	349	1166	394
Pompholyx sulcata			102	51	49	36	50	51	338					
Asplanchna sieboldi				72	51	95	51	51	52					
A. priodonta	1390	2237	5379	8904	5618	5720	4445	3288	1343	901		901	757	
Synchaeta pectinata	1482	4515	4122	4927	4601	3311	2161	1528	1780		1457	840		
Filinia terminalis		53	52		51			99	254					
F. longiseta	48					50								
Lecane lunaris	49			50	58									
Notholca squamula		56				59	57							
Brachionus angularis								50						
Rotaria neptunia								40	300			662		
Hexarthra oxyuris	10090	11944	5903	1961	745	311	360	316	261			1184		
Colurella adriatica	51													
Total	**44104**	**121268**	**192829**	**224155**	**164852**	**153080**	**99923**	**78854**	**31126**	**12928**	**8281**	**23150**	**17315**	**3393**
%	3.75	10.32	16.40	19.07	14.03	13.02	8.50	6.71	2.65	1.1	0.70	1.97	1.47	0.28
photic, aphotic %			**63.58**							**36.42**				

Analyses revealed that 34.59% of rotifers at surface was *P. dolichoptera* (603107 ind m^{-3}) and 29.29% of rotifers below surface was *K. cochlearis cochlearis* (449553 ind m^{-3}). On the other hand the least abundant species at surface was *Hexarthra intermedia* which represented 0.01% of total Rotifera while there were two species namely *B. angularis* and *C. adriatica*, each of which representing only 0.003% of Rotifera below surface.

Rotifer-chlorophyll *a* interaction

Analyses between rotifer and chlorophyll *a* interaction monthly and vertically given in Figure 1 and Figure 2, respectively.

While the level of chlorophyll *a* decreased gradually from April to July at surface and from April to August below surface, a gradual increase at the number of rotifer was observed. Both the number of rotifer and the level of chlorophyll *a* has fluctuated independently from August onwards (Figure 1).

In consideration of vertical relation between the number of rotifers and the chlorophyll *a* level, both showed a gradual increase up 5 m. The number of rotifer reached to the highest number at 5 m whereas the level of chlorophyll *a* was the highest at 7.5 m. Both values reached to the lowest level at 50 m (Figure 2).

As a result of this study a total of 35 species of rotifer has been determined a first record for Aslantas Dam Lake. 33 of them are species and 2 of them are subspecies. Species of Hexarthridae two which determined in Aslantas Dam Lake, is reported to be likely inhabitants of freshwater (Demirhindi, 1972) and they are observed previously, 13 different resoirvuar in Turkey (Demirsoy, 1996). However *Hexarthra oxyuris* is reported to live in brackish and saline water (Dumont and Ridder, 1987; Ustaoğlu and

Akyürek, 1994; Brock and Sheel, 1983; Dumont, 1981). These reports show that species of Hexarthridae are mostly euryhaline.

Some of the species i.e., *K. longispina*, *Lecane luna* and *Notholca squamula* inhabits both freshwater and saline habitats. *Lepadella ovalis* prefers brackish waters and marshlands. Some species occur only a period of year. For example, *Rotaria neptunia* and *B. angularis* can be observed only in winter and spring. However, some others, e.g. *C. gibba* and *A. priodonta* can be found all year around (Saler and Şen, 2000). It is reported that *B. calyciflorus* can be found frequently in warm waters; *Keratella quadrata* lives in all waters as well as oligothrophic and eutrophic lakes (Emir, 1990); Mathew (1979) reports that *Pompholyx sulcata* is a winter species while *Hexarthra intermedia* is a hypertermic species. *K. longispina* is reported to be a hypothermic species (Primicerio and Klemetsen, 1999). This is also supported with the presence of the species in considerably cold water of Turkey such as Abant Lake, Yedigöller and Cip Dam Lake.

The presence of afore mentioned species in Aslantas Dam Lake are related with ecological requirements of these species. However, the presence of *L. ovalis*, a brackish water and marshland species, all year around and the presence of hypothermic *K. longispina* in July when Aslantas Dam Lake is not cold at all, is very interesting.

Analyses reveal that the rotifers are distributed abundantly near surface and the total number is the highest at 5 m (Figure 3). Previous reports on the depth dependent distribution of zooplankton claims that rotifers does not show orderly vertical taxis. Instead, most of them prefer proximities close to the surface although they are not likely to be at the surface. However, the number of rotifers decreases as the depth increases (Kolisko, 1974). Nevertheless there are examples of species i.e. *Rotaria neptunia*, found in depths (Ventela et. al., 1997). Dumont and Ridder (1987) reports that *Hexarthra oxyuris* shows distribution between 5-20 m we have obtained similar results with *R. neptunia* which was observed between 20-35 m. *H. oxyuris* was distributed up to 30 m and they were mostly abundant at 1 m as it is in line with the report of Kolisko (1974).

Kolisko (1974) claims that zooplankton such as rotifers densely, inhabit photic zone where there is an abundance of food as well. Therefore rotifers often do not migrate vertically. Similar findings were obtained as a result of this study. Most of the total Rotifera (63,58%) was collected from photic zone. The remaining 36,42% of Rotifera was obtained from aphotic zone.

Reporters agree that there is a close relation between phytoplankton and zooplankton as far as food chain is concerned. An increase in the number of zooplankton results in a consequential decrease in the number of phytoplankton. The number of zooplankton, usually, increases following the period of phytoplanktonic renewal and development (Cirik and Cirik, 1991; Kolisko, 1974; Horn and Goldman, 1994; Wu and Culver, 1991; Noges, 1997). We have similarly, shown that relatively low number of rotifer was observed while chlorophyll *a* were increasing gradually. In contrast, a low level of chlorophyll *a* was determined when the rotifer reached to their peaks. However, a deviation from the reports was observed when the relation between rotifers and chlorophyll *a* in depths is examined. We found that the number of rotifer decreased when the level of chlorophyll *a* decreased in depths and vice verse.

Brachionus calyciflorus, B. angularis, K. quadrata, K. cochlearis tecta, Euchlanis dilatata, L. luna, Pompholyx sulcata, Filinia longiseta are reported to be eutrophic species (Rylov, 1963; Borutski, 1963; Brooks, 1971; Voigt and Koste, 1978). However, Kolisko (1974) claims that most of these species inhabits oligotrophic lakes of temperate climates even though they are few in number (200-500 ind L^{-1}). The value of chlorophyll *a* (31.44 mgm^{-3}) confirms that Aslantas Dam Lake is characteristically not eutrophic.

Conclusions

In conclusion, rotifers in Aslantas Dam Lake are represented with 33 species and 2 subspecies. Some of rotifer species showed tendency to live at surface, for example, *Lepadella ovalis*, *Lecane luna*, *L. stenroosi*, *L. lunaris*, *L. Bulla*, *Cephalodella gibba*, *Euchlanis dilatata*, *Scaridium longicaudum*, *Trichotria tetractis*, *Brachionus angularis*, *B. calyciflorus*, *Colurella adriatica* and *Kellicottia longispina*. On the other hand, the species living below the surface only was *Keratella quadrata*. Rotifer species were mainly distributed between 2.5 and 10 m. It was found out that the number of total Rotifera increased up to 5 m. There was a constant decrease

up to 33 m from 5 m onwards. The number of total Rotifera was the least at 50 m. Thus, it was found that more rotifer species preferred to live in photic zone (63.58%) and less of them preferred (36.42%) in aphotic zone.

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