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## A Study on Zooplankton Organisms Community Structures of Lake Terkos (Istanbul-Turkey)

Hüseyin Güher, Timur Kirgiz, Belgin Çamur, Utku Güner  
Trakya University, Science and Arts Faculty, Department of Biology, TR-22030, Edirne, Turkey

**Abstract:** This research has been conducted to determine seasonal changes of zooplanktonic organisms (Rotifera, Cladocera, Copepoda) in the lake Terkos. Zooplankton samples have been collected in five different stations in monthly periods between April 2000-March 2001. As a result, 1992556 ind m<sup>-3</sup> was found in lake Terkos and it is made up of 1177334 ind m<sup>-3</sup> Rotifera (59.1%), 117583 ind m<sup>-3</sup> Cladocera (5.9%) and 697639 ind m<sup>-3</sup> Copepoda (35%).

**Key words:** Zooplankton, seasonal changes, lake, Terkos.

### INTRODUCTION

Zooplanktonic organisms are basic food for fishes that live in fresh water ecosystems; besides, they include indicator species that determine water quality, pollution and the state of autrophication. For this reason, many researches have been conducted in terms of both taxonomical and ecological, aspects on zooplanktonic organisms.

Lake Terkos, which supplies the big quantity of the drinking water of Istanbul, is one of the most important wetlands in Turkey. While the various routine measurements, which aim to determine the quality of drinking water in lake, were being conducted by ISKI (Istanbul Water and Sewerage Manage) and DSI (State Water Works), Altınsoğlu and Yılmaz<sup>[1]</sup> conducted researches concerning the Ostracoda fauna of the lake. No research record regarding the seasonal changes of zooplanktonic organisms of the lagoon lake, which was directly connected to Black Sea until 1881 but whose connection was partially broken up after that date, has been found. This study has been conducted with the aim of showing the seasonal changes of zooplanktonic organisms (Rotifera, Cladocera, Copepoda) that live in lake Terkos and the relationship between these changes and some of the physical parameters of lake.

### MATERIALS AND METHODS

This study was performed in the form of sampling trips with monthly intervals between April 2000 and March 2001. Plankton samples were collected with the Hensen type Plankton nets (mesh size 55 µm) vertically up

to the surface from the bottom point at five stations (Fig.1). In every station two samplings were carried out and then the samples were put in the 250 ml bottles containing 70% alcohol inside.

After providing to make the plankton samples in the laboratory homogenous, 10 ml quantity was taken and put in the counting container and all of the samples were counted under the microscope. This process was repeated for 10 times totally and the average number of individual in 10 ml was determined. The method of Edmondson<sup>[2]</sup> was followed in order to find the individual number in m<sup>3</sup> of the plankton samples. Kolisko<sup>[3]</sup>, Koste<sup>[4]</sup>, Smirnov<sup>[5]</sup>, Margaritora<sup>[6]</sup>, Korinek<sup>[7]</sup>, Dussart<sup>[8, 9]</sup> and Kiefer<sup>[10]</sup> were used for species identification for various diagnoses. The average individual number of organisms in m<sup>3</sup> per station, month and season was determined.

Dissolved O<sub>2</sub>, pH, temperature, secchi disk depth, depth and salinity were determined at every station.

**Description of the study place:** Lake Terkos is 50 km far from Istanbul, placed in the North-West of Istanbul and between 40°19' North, 28°32' East coordinates. Although it had been connected directly with Black Sea until 1881, now its connection is ended with a regulator in order to supply the water need of Istanbul. The lake has been separated from the Black Sea with sand and hills that can change between 0.25-3.7 km from place to place. It is 14 km long, 6 km wide, it has 25 km<sup>2</sup> surface and it is approximately 11 m deep at most. Istranca stream and lots of small streams pour their water in it (Fig. 1). Furthermore, the water of some streams of Istranca flowing directly into the black sea is pumped into the lake by means of various regulators.

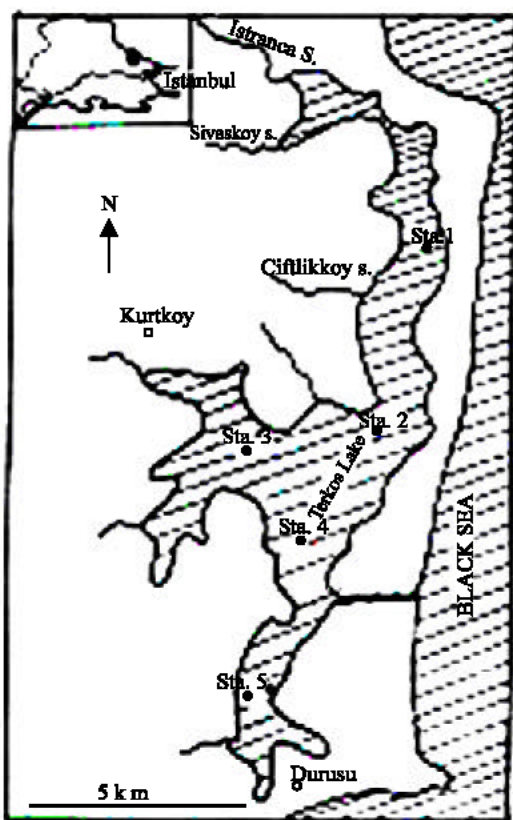


Fig.1: The location of the lake Terkos and sampling stations

There are water plants around the lake from point to point especially in the joint areas of streams (*Phragmites australis*, L., *Trapa natans*, L., *Nymphaea* sp. ).

## RESULTS

In our study we determined 19 taxon, which are from Rotifera group that forms most of the zooplanktonic organisms in fresh water, 10 taxon from the Cladocera group, 5 taxon from Copepoda group and Nauplius that belongs to Copepoda group (Table 1).

In quantitative evaluation of samples, on average 1992556 individual in  $m^3$  of the lake Terkos were determined. While the amount of zooplankton in lake is in its summit in September, it falls its lowest level in November, January and October (Table 1). Although there is no extreme fluctuation distribution among stations, the lowest individual was found in 5. station. In seasonal change summer is the season when the amount of zooplankton is in its the highest and winter is the time when it is in its lowest.

The zooplankton population in the lake is formed by 59.1% Rotifera, 5.9% Cladocera, 35% Copepoda

individuals (Fig. 2). Distributions of groups according to the months, stations and seasons are giving below,

**Rotifera:** Rotifera, which was found as approximately 1177334 individuals in  $m^3$  of the lake, reaches its highest number with 19.7% in July, 14.9% in June and 13.8% in September. It was found in its lowest level with 1% in October. In terms of number of species May and April are the month's species are varied at the most and July, September and October are the months species varied at the lowest. When we examine the amount of individual according to the species found, While *Asplanchna* sp., which was found during 12 months, take the first place with 46% and *B. angularis* 15.3%, *K. quadrata* 14.8%, *Trichocerca* sp. 8.5% follow it. *Hexarthra* sp. and *N. acuminata* are the species which are found in the lowest level in the lake (Table 1).

Among the stations, the second station has the highest level of individual with 28.6%, subsequently the first station with 20.3%, the fifth station 18%, the fourth station with 16.6%, the third station with 16.5% (Fig. 3). The second station also has the highest number of species.

In seasonal distribution summer is the time when Rotifera reaches its highest level with 43.6% and winter is the season when it reaches the lowest level with 15.5% (Fig. 4). Spring is the season when the most of the variety of the species is observed.

**Cladocera:** Cladocera, which was found approximately as 117583 ind  $m^{-3}$  in the lake, reaches its highest level with 42.4% in September. August with 17.8%, July with 14.1% follow it. It was found that its lowest level was 1.3% in April, subsequently, 1.5% in March, 1.6% in February. In terms of the variety of species April and September are the months when the variety of species is the highest but November and December are the months when it is the lowest (only *B. longirostris*). According to the number of species *B. longirostris*, which was found throughout 12 months, takes the first place with 63.2%. *D. brachyrum*, which was found throughout 6 months, follows it with 22.9%. *L. kindti*, *M. laticornis*, *I. sordidus* and *A. quadrangularis* were found in lowest level (Table1).

Although there is no distinct difference between stations, the third station becomes first with 24.4% and the fifth station becomes last with 14.5% (Fig. 5) the first and second stations are the ones which have the highest number of species.

In seasonal distribution in autumn Cladocera is in its maximum level with 55.3% and it is in its minimum in spring with 4.9% (Fig. 6). Spring has also the highest number of species.

Table 1: The monthly distributions of zooplanktonic organisms groups in the lake Terkos (ind m<sup>-3</sup>)

	April 29.4.00	May 29.5.00	June 30.6.00	July 30.7.00	Aug. 28.8.00	Sept. 28.9.00	Oct. 29.10.00	Nov. 27.11.00	Dec. 5.01.00	Jan 31.01.01	Feb. 27.02.01	March 27.03.01	average	%
<b>ROTIFERA</b>														
<i>Brachionus unceolaris</i>	31297	8428	9938	-	-	-	-	-	29872	16712	175927	39898	26006	%2,2
<i>Brachionus angularis</i>	6532	171233	1345377	70139	199780	17099	4691	10765	46662	-	276557	30953	181649	%15,3
<i>Brachionus sp.</i>	-	-	87413	-	12935	-	-	3587	1632	34317	-	-	11657	%1,0
<i>Keratella cochlearis</i>	-	-	-	-	-	-	-	241556	60661	57999	-	-	30018	%2,5
<i>Keratella quadrata</i>	423216	79257	68732	6066	12935	-	-	8971	530148	198595	300219	480729	175739	%14,8
<i>Keratella sp.</i>	25271	8620	24166	-	-	-	-	-	-	-	-	9875	5661	%0,5
<i>Notholca acuminata</i>	1214	849	-	-	-	-	-	4177	-	-	-	-	520	%0,1
<i>Anuraeopsis sp.</i>	10560	-	-	-	-	-	-	-	-	-	-	-	880	%0,1
<i>Trichocerca sp.</i>	-	73415	16520	39791	34481	934911	86842	5790	1902	-	4177	-	99819	%8,5
<i>Lecana nana</i>	8546	-	37329	-	-	-	-	3588	-	-	-	-	4122	%0,4
<i>Cephalodella gibba</i>	-	27373	-	-	-	-	-	-	-	-	-	-	2281	%0,2
<i>Polyarthra vulgaris</i>	30415	33970	-	-	-	-	9384	5791	-	-	-	-	6630	%0,6
<i>Polyarthra sp.</i>	-	38689	-	-	-	-	-	29855	-	-	-	-	5712	%0,5
<i>Synchaeta sp.</i>	-	5660	18580	-	-	-	-	-	-	-	-	-	2020	%0,2
<i>Asplanchna sp.</i>	367427	717426	436249	2667513	1002913	989970	43732	37845	40441	104582	73680	17950	541644	%46,0
<i>Hexarthra intermedia</i>	1760	-	54918	-	11249	-	-	-	51396	-	159983	634470	76148	%6,5
<i>Hexarthra sp.</i>	-	-	-	-	-	-	-	-	-	4596	-	-	383	%0,1
<i>Filina logiseta</i>	14816	11323	5409	-	-	-	-	-	-	-	-	-	2629	%0,2
<i>Filina terminalis</i>	-	-	-	-	-	13189	-	-	-	3519	14135	14949	3816	%0,3
Total Rotifera	921054	1176243	2104631	2783509	1274293	1955169	144649	351925	762714	420320	1004678	1228824	1177334	
<b>CLADOCERA</b>														
<i>Bosmina longirostris</i>	5292	3589	12615	144117	130256	344488	56426	106886	19283	41045	15165	12378	74295	%63,2
<i>Ilyocryptus sordidus</i>	880	-	-	-	-	2637	4691	-	-	-	-	-	684	%0,6
<i>Macrothrix laticornis</i>	3696	-	-	-	-	-	-	-	-	-	-	-	308	%0,3
<i>Alona quadrangularis</i>	1464	-	-	-	-	3724	-	-	-	3224	2088	-	875	%0,7
<i>Alona guttata</i>	-	-	-	-	-	5408	-	-	-	-	2187	4657	1021	%0,9
<i>Pleurocus aduncus</i>	2124	-	-	-	-	-	-	-	-	-	3615	3597	778	%0,7
<i>Diaphanosoma brachyrum</i>	-	943	12482	29155	106887	164093	9384	-	-	-	-	-	26912	%22,9
<i>Leptodora kindtii</i>	-	-	-	-	1800	-	-	-	-	-	-	-	150	%0,1
<i>Cercopagis sp.</i>	3196	25727	-	7549	3588	5408	-	-	-	-	-	-	3789	%3,2
<i>Comigerus sp.</i>	1572	-	-	18300	8716	71972	4692	-	-	-	-	-	8771	%7,5
Total Cladocera	18224	30259	25097	199121	251247	597730	75193	106886	19283	44269	23055	20632	117583	
<b>COPEPODA</b>														
<i>Eurytemora velox</i>	4412	2895	41036	4641	33813	76725	-	-	-	2054	-	-	13798	%2,0
<i>Calanipeda aguae dulcis</i>	12679	-	7245	18638	12878	87707	21569	-	-	-	-	-	13393	%1,9
<i>Calanoid Copepoda</i>	93791	36046	87973	74275	268266	849676	144196	54044	21724	148791	22692	124622	160508	%23,0
<i>Harpacticoid Copepoda</i>	1088	849	-	23987	5021	9231	-	5970	-	7914	-	2088	4679	%0,7
<i>Cyclopoid Copepoda</i>	1088	-	-	1435	-	-	-	-	-	11433	-	-	1163	%0,2
<i>Cyclops sp</i>	1980	-	-	-	-	-	-	-	-	-	-	-	165	%0,1
<i>Nauplius</i>	390213	104080	104093	200327	1653687	1822144	477112	213404	184108	271945	270150	355933	503933	%72,1
Total Copepoda	505251	143870	240347	323303	1973665	2845483	642877	273418	205832	442137	292842	482643	697639	
GENERAL TOTAL	1444529	1350372	2370075	3305933	3499205	5398382	862719	732229	987829	906726	1320575	1732099	1992556	

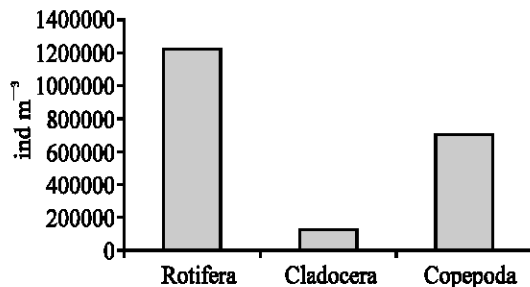


Fig. 2: Groups distributions of zooplanktonic organisms in the lake Terkos (ind m<sup>-3</sup>)

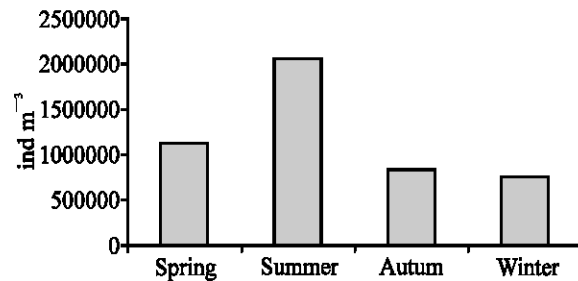


Fig. 4: Seasonal distributions of Rotifera in the lake Terkos (ind m<sup>-3</sup>)

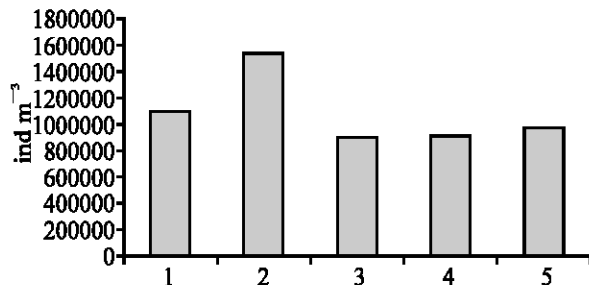


Fig. 3: The stations distributions of Rotifera in the lake Terkos (ind m<sup>-3</sup>)

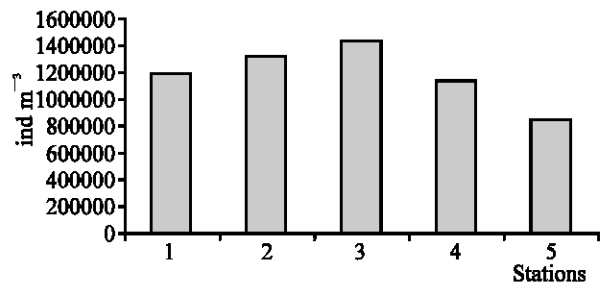


Fig. 5: The stations distributions of Cladocera in the lake Terkos (ind m<sup>-3</sup>)

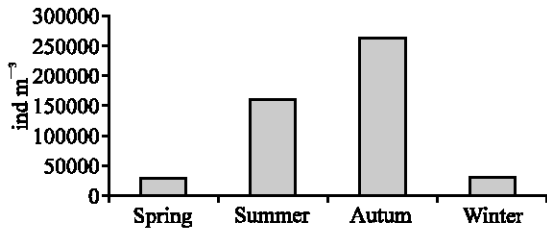


Fig. 6: Seasonal distributions of Cladocera in the lake Terkos (ind m<sup>-3</sup>)

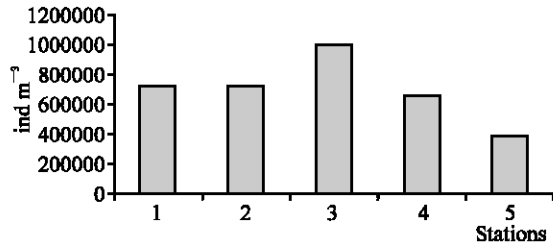


Fig. 7: The stations distributions of Copepoda in the lake Terkos (ind m<sup>-3</sup>)

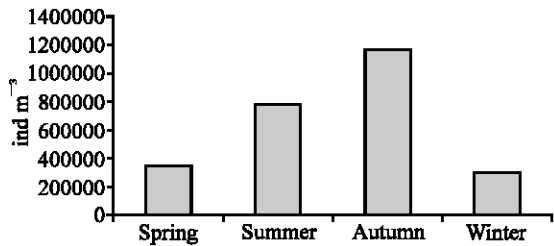


Fig. 8: Seasonal distributions of Copepoda in the lake Terkos (ind m<sup>-3</sup>)

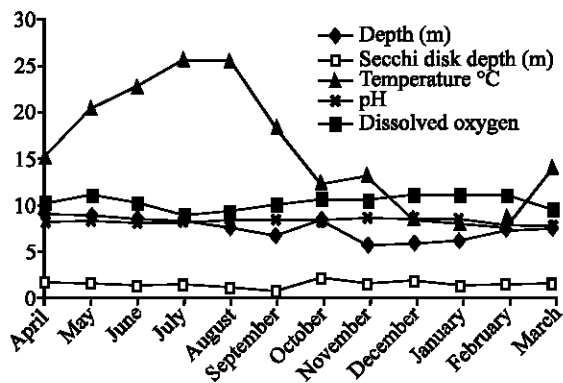


Fig. 9: Physical parameters measured in the lake Terkos

**Copepoda:** Copepoda, which was found as approximately 697639 ind m<sup>-3</sup> reaches its highest level in September with 34%, August 23.6%. Although the numbers are roughly equal in other months, it decreases to its lowest level in May 1.7%. In terms of species numbers April and July are the months with the highest number. According to the

distribution of species in 12 months existence, Nauplius takes the first place with 72.1% and Calanoid Copepoda follows it with 23%. *Cyclops* sp. Individuals were found in lowest level (Table 1).

Although there is no distinct difference between stations, the third station is the first with 28.8% and the first station with 20.9%, the second station with 20.7%, the fourth station with 18.6% and the fifth station with 10.9% follow it (Fig. 7). While all of the individuals exist in every station, *Cyclops* sp. exists only in fourth station.

In seasonal distributions, Copepoda reaches to the highest level in autumn with 44.9%. Winter is the season when it is in its lowest level with 11.2% (Fig. 8). In terms of the variety of species, although there is not much difference from season to season, spring is relatively rich.

The physical parameters we observed in the lake Terkos were 8.9-11.1 mg l<sup>-1</sup> for dissolved oxygen, 7.6-8.5 for pH, 0.05-0.007% mg l<sup>-1</sup> for the salinity, 0.65-2.04 m for light transparency. The temperature was measured in the lowest level as 7°C in February and the highest level as 26°C in July. While the deepest point was measured 11 m in the third station in April, the lowest was measured in fourth station in November. Lake's average depth can change between 5.65-8.91 m (Fig. 9).

## DISCUSSION

Average 1992556 individual were found in m<sup>3</sup> in this research conducted in the lake Terkos. It is made up of 1177334 ind m<sup>-3</sup> Rotifera (59.1%), 117583 ind m<sup>-3</sup> Cladocera (5.9%) and 697639 ind m<sup>-3</sup> Copepoda (35%). Rotifera is the dominant group among zooplanktonic organisms in fresh water<sup>[11]</sup>. Which is consistent with our findings.

Rotifera is mostly (76.3%) made up of *Asplanchna* sp., *B. angularis*, *K. quadrata* individuals. *Asplanchna* sp. and *K. quadrata* can tolerate temperature increase and can be detected throughout the year<sup>[12]</sup>. *Brachionus* sp. individuals commonly live in water with low salinity<sup>[3]</sup>. 12-month existence as large numbers of this species is an observation parallel with the findings of the both authors.

Sladeczek<sup>[13]</sup> and Emir<sup>[14]</sup> define the proportion of *Brachionus* to *Trichocerca* as eutrophication index in a lake. They stated that when this proportion becomes 1, situation is called as oligotrophic, when between 1-2, the situation is called as mesotrophic, if bigger than 2, it is called eutrophic. The proportion of total *Brachionus* individual to *Trichocerca* was found as (219312 / 99819) 2.19

In Cladocera, which is found in large numbers in all seasons, *B. longirostris* and *D. brachyrum* are the species that commonly live in every kind of fresh water.

While Nauplius individuals are the largest in Copepoda, adult individuals couldn't be found at the same number. This shows that a number of Copepoda individuals are mostly reduced before being adult by various environmental factors and predator pressure.

In our research we found that while Rotifera population increases in summer, Cladocera and Copepoda populations increase in autumn. In a fresh water ecosystem the quantity of phytoplankton organisms changes depending on weather and light quality. Depending on the increase of the number of phytoplankton, Rotifera density starts to increase in spring and in summer it reaches to the highest level. Parallel to the increase in Rotifera population, Cladocera and Copepoda individuals that are the predators of them begin to increase in summer and it reaches to maximum in autumn. As a result of this, there is a decrease in the Rotifera population in this season.

It can be said that the lake has a eutrophic character according to certain physical parameters. In addition the population density of *Brachionus* and *Keratalla* species the other important eutrophic indicators for the lake Terkos and the proportion of *Brachionus* to *Trichocerca*.

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