Journal of Animal and Veterinary Advances 11 (17): 3045-3049, 2012
ISSN: 1680-5593

An Investigation on the Distribution of Mollusc Fauna of Lake Terkos (Istanbul/Turkey) Related with Some Environmental Parameters

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Abstract: The aim of this study is that to investigate both ecological and numerical species assemblages of mollusc fauna of Lake Terkos (Istanbul, Turkey). In order to determine the mollusc fauna of Lake Terkos (Turkey) samples were collected from 5 stations monthly between February, 2008 to January, 2009. While a total of 11 mollusc species were found at the sampling stations, it was determined 817 individuals in per m^2 at average. Six species of them (*Physella acuta*, *Galba truncatula*, *Radix labiata*, *Lymnaee stagnalis*, *Planorbis planorbis* and *Planorbarius corneus*) belong to Pulmonota, two taxa of them (*Viviparus viviparus costae* and *Bithynia tentaculata*) belong to Prosobranchia and three species of them (*Unio pictorum*, *Dreissena polymorpha* and *Anodonta cygnea*) belong to Bivalvia. Furthermore in each samples water temperature, dissolved oxygen, pH, Ca, Mg, NO_2-N, NO_3-N and NH_3 measured at the sampling sites. Canonical Correspondence Analysis (CCA) explained 91.8% of the correlation between species and environmental variables. Water temperature (t), Dissolved Oxygen (DO), Ca, Mg and pH were most affective variables on the species absence.

Key words: Mollusca, Lake Terkos, canonical correspondence analyse, physico-chemical parameters, species, Turkey

INTRODUCTION

Mollusc in general can be found in most types of water including fresh, brackish and saline as well as their combinations. Freshwater molluscs are important group in ecosystems. According to Oktener, this makes them suitable for studies of the relationship between the organism and the environment. In a lot of studies, Macan (1950), Hunter (1961), Dussart (1976), Chatterjee *et al.* (2008), Dillon (2000) and Maltchik *et al.* (2010) have demonstrated the importance of the relationships between ecological factors and freshwater gastropods. Important ecological works on freshwater molluscs were by Cabuk *et al.* (2004), Sereflisan *et al.* (2009), Sahin and Yildirim (2007) and Odabasi *et al.* (2009) in Turkey.

Up to now, the mollusc fauna of Lake Terkos was reported by Camur-Elipek (2003), faunistically. In this study both the composition of mollusc fauna and environmental features which effected on their distribution was investigated.

Lake Terkos is one of the six main freshwater reservoirs for Istanbul Metropolitan providing 25% of tap water demand. The lake is a lagoon located near the Black Sea coast of Turkey that approximately formed at the end of the quaternary (Baykal *et al.*, 1999). The area of the lake is 25-32 km^2 and the elevation varies from -1 to +4 m and it has a maximum depth of 10 m. In recently increasing industrious factories, number of settlements, agricultural areas around the lake and their wastes which may affect the qualitative and quantitative distributions of molluscs are potential threats for the lake ecosystem.

MATERIALS AND METHODS

Sampling was done monthly at 5 different stations in Lake Terkos using Ekman grap (225 cm^2) between February 2008 and January 2009 (Fig. 1). Mollusc samples were collected 0.5 m from the opening. Samples were preserved in 70% ethanol within plastic bottles. It was used Schutt (1988), Macan (1969, 1977), Zhadin (1965) and Gloer to taxomical identification of the specimens. While

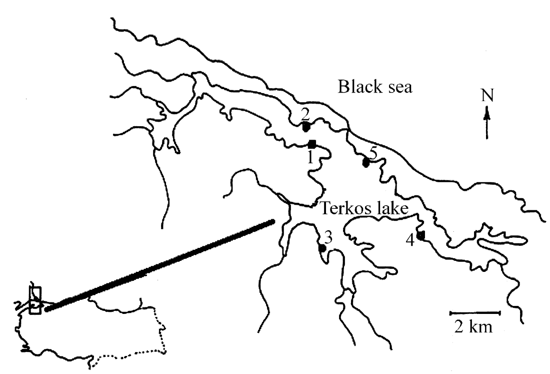

Fig. 1: The locations of the sampling stations at Lake Terkos

the water temperature, pH, dissolved oxygen were measured in the field the values of Ca, Mg, NO_3-N, NO_2-N and NH_3 were determined in the laboratory within 24 h according to Claude *et al*. (1992). To learn the relationships between species and environmental variables, the Canonical Correspondence Analyse (CCA) (Ter Braak, 1986) was used to data.

RESULTS AND DISCUSSION

In this study, a total of 11 mollusc species were identified at the sampling stations in Lake Terkos (Table 1). It was found that two species of them (*Viviparus viviparus costae* Mousson, 1863, *Bithynia tentaculata* (L., 1758) belong to Prosobranchia, 6 species of them (*Physella acuta* Draparnaud, 1805, *Galba truncatula* (O.F. Muller, 1774), *Radix labiata* (Muller, 1774), *Lymnaee stagnalis* (L., 1758), *Planorbis planorbis* (L., 1758), *Planorbarius corneus* (L., 1758)) belong to Pulmonota and three species of them (*Unio pictorum* (L., 1758), *Dreissena polymorpha* (Pallas, 1771), Anodonta *cygnea* (L., 1758) belong to Bivalvia. In this study, it has been calculated 817 individuals in per m^2 at average in the lake and *V. viviparus* was found to have the most dominant species. While *D. polymorpha* was detected in all sampling stations, it was accrossed *B. tentaculata* rarely during the studied period (Table 1).

Anodonta cygnea have been identified as a rare species in the same way. The best growth of this species range is 5-25°C. Also, *Anodonta cygnea* is prefer eutrophic and hypoxic lakes (Rycken *et al*., 2003). In this study, the maximum of this species were found individual numbers 489 pre m^2. In addition the pulmonate species belonging to the genus *Physella* are considered as biological indicators of organic pollution and eutrophication. In this study, *P. acuta* was found in the individual 756 per m^2 (Table 2). Furthermore, some physico-chemical features of Lake Terkos at sampling period were shown in Table 2. The Water Temperature (WT) were measured between 6.3-31.4°C; Dissolved Oxygen measured (DO) 5.6-11.2 mg L^{-1}, pH values 7-8.1, Ca between 39.3-56.1 mg L^{-1} and Mg: 3.7-9.8 mg L^{-1}. NO_2-N between <0.01-0.07 mg L^{-1}, NO_3-N between 0.01-7.37 mg L^{-1} and NH_3 between 0.01-0.1 mg L^{-1}. Reduction of water level might have caused the changes in the physical and chemical properties and in species occurence patterns as well. Because of the rapid changes, species should change their tolerance levels to increase their survival chances in the lake.

Dissolved oxygen level of the water was a significant parameter for the abundance species (Hart and Samuel, 1974). The highest number of individual were observed in Spring and Summer (Fig. 2a and b).

pH is important factor that influence metabolic activities and thereby the growth and abundance of

Table 1: Some physico-chemical features and finding samples of Lake Terkos in sampling period

Seasons	St.	DO (mg L^{-1})	WT (°C)	pH	Ca (mg L^{-1})	Mg (mg L^{-1})	NO_2-N (mg L^{-1})	NO_3-N (mg L^{-1})	NH_3 (mg L^{-1})	Species
Spring	1	6.3	25.8	7.0	40.1	3.7	0.03	5.32	0.04	Vv, Pp, Pa, Ls, Dp, Ac
	2	10.9	26.1	7.2	39.8	3.8	0.07	6.03	0.07	Vv, Pc, Pp,
	3	10.4	25.9	7.5	39.2	4.1	0.04	2.02	0.02	Vv, Pp, Dp, Bt, Gt, Rl, Ls, Dp
	4	7.4	26.3	7.9	40.2	4.2	<0.01	0.04	0.01	Pp, Dp, Gt, Rl
	5	6.0	24.6	7.2	40.1	4.6	<0.01	0.03	0.01	Up, Dp, Ac, Pp, Pa, Bt,
Summer	1	5.6	25.9	7.3	39.3	4.1	0.01	7.12	0.08	Bt, Vv, Pp, Pc, Pa, Ls, Dp, Ac
	2	8.8	27.0	7.8	39.6	4.2	0.06	7.37	0.10	Vv, Ls, Dp
	3	9.3	26.4	7.2	40.2	4.3	0.01	1.06	0.01	Pp, Dp, Rl, Ls, Dp
	4	5.8	27.8	7.6	41.3	4.6	0.06	3.03	0.03	Vv, Pp, Dp
	5	5.7	31.4	7.2	40.2	4.2	0.05	5.03	0.05	Vv, Pp, Pc, Pa, Ls, Dp, Ac
Autumn	1	9.3	14.6	7.9	40.3	5.5	<0.01	2.01	0.02	Dp, Ls
	2	8.6	14.9	8.1	40.5	4.9	<0.01	1.18	0.01	Dp
	3	5.8	15.3	7.3	40.1	5.7	<0.01	2.51	0.10	Pp, Dp
	4	8.2	16.5	7.8	41.2	8.8	<0.01	1.60	0.01	Dp, Up
	5	7.9	13.5	7.6	42.6	7.9	<0.01	0.09	0.01	Dp, Ac
Winter	1	11.2	9.6	7.4	41.5	9.3	<0.01	0.03	0.01	Dp
	2	10.0	9.1	7.3	42.3	9.8	<0.01	0.50	0.01	Dp, Bt
	3	9.3	8.6	7.1	47.5	9.3	<0.01	1.01	0.01	Dp
	4	10.3	9.6	7.1	50.1	8.9	<0.01	0.01	0.01	Dp
	5	8.7	6.3	7.6	56.1	9.5	<0.01	1.01	0.01	Dp, Up, Ac

St: Stations, DO: Dissolved Oxygen, WT: Water Temperature, NO_2-N: Nitrite, NO_3-N: Nitrate NH_3: ammonia, Vvc: *Viviparus viviparus costae*, Bt: *Bithynia tentaculata*, Pa: *Physa acuta*, Gt: *Galba truncatula*, Lp: *Lymnea peregra*, Ls: *Lymnaee stagnalis*, Pp: *Planorbis planorbis*, Cc: *Coretus corneus*, Up: *Unio pictorum*, Dp: *Dreissena polymorpha*, Ac: *Anadonta cygnea*

Table 2: Species abundance (individual per m^2)

	Station					
Species (%)	1st	2nd	3rd	4th	5th	Average
Galba truncatula (5%)	488	44	80	133	44	158
Bithnynia tentaculata (1%)	-	-	44	-	44	18
Radix labiata (11%)	356	-	356	489	578	356
Viviparus viviparus costae (30%)	89	1422	489	756	2133	978
Physella acuta (8%)	-	44	756	578	-	276
Lymneae stagnalis (18%)	711	311	578	89	1244	587
Planorbarius corneus (4%)	44	89	489	44	-	133
Planorbis planorbis (2%)	89	-	133	44	-	53
Anadonta cygnea (4%)	89	-	89	-	489	133
Dreissena polymorpha (12%)	711	44	44	311	933	409
Unio pictorum (5%)	311	44	-	89	400	169
Average	722	499	764	633	1466	817

Table 3: CCA eigenvalues of Lake Terkos

Parameters	Axis 1	Axis 2
Eigen values	0.19	0.15
Value (%)	18.78	14.73
Total value (%)	18.78	33.50
Total limited percent	28.94	51.63
Species-environment relationship	0.91	0.96

freshwater molluscs (Eleutheriadis and Dimitriadou, 1995). Low pH values (<6.0) were reported to be unfavourable for mollusc growth (Hart and Samuel, 1974; Dussart, 1976). In this study variation of pH are between 7-8.1 (Table 1). The lowest pH value was measured in the field as 7 (at Station 1 in Spring samples). Because of non-occurence of extreme variation pH has not been considered as restrictive factors for the mollusc community. Water temperature was found at normal levels (6.3-31.4°C) during the study period.

Cosmopolitan species can tolerate substantial changes in water quality. Accordingly, increasing numbers of cosmopolitan species can signal an increase in levels of human disturbance and pollution (Robert *et al*., 1999). In the result of the CCA analysis, (Fig. 3) *D. polymorpha* was cosmopolitan species. CCA axes (Axis 1 and 2) explained 91.8% of the varience in the species abundance data (Table 3). Arrows represent environmental variables (Fig. 2). Accordingly, temperature, pH, Ca, Mg and NO_2-N most significant ($p<0.05$) variables with respect to species occurence of molluscs. In addition to calcium is an essential requirement for the successful growth and development of gastropod molluscs (Briers, 2003; Rycken *et al*., 2003). In this study CCA supports that information as a result of the analysis (Fig. 3). Correspondence analyses showed that the majority of the mollusc species investigated seems to have a wide range of tolerances to different environmental variables (Fig. 3). Normal seasonal variations of temperature were observed in all stations during the study period.

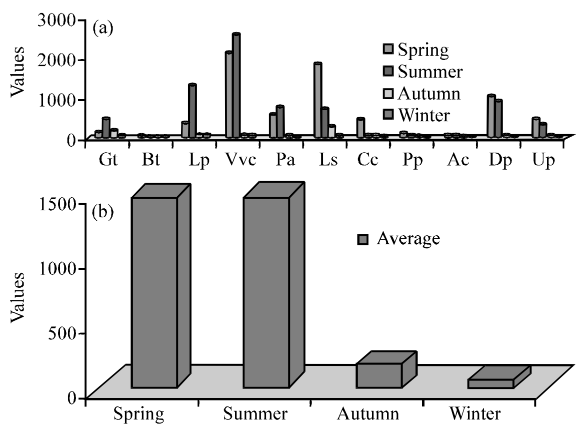

Fig. 2a, b): Species composition of molluscs in Lake Terkos to the seasonally

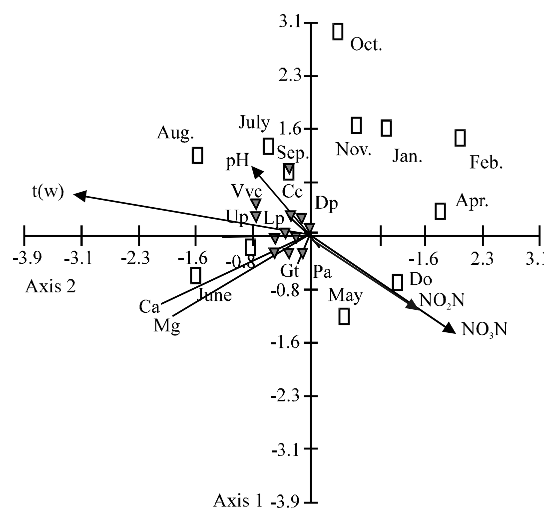

Fig. 3: The CCA diagram of months, species and environmental parameters in Lake Terkos

Changes in water quality will alter the function and species composition of lake. According to Soylu, *Theodoxus fluviatilis*, *Viviparus costae* and *Dreissena polymorpha* were the most dominant species. But in this study *Viviparus viviparus costae*, *Lymnaee stagnalis*, *Dreissena polymorpha* and *Lymnea (Radix) peregra* were the most dominant species (Table 2). The diversity of ecological conditions thought to be effective. The stations with the highest species numbers were 5, 3, 1 followed 4 and 2. Correspondence analyses showed that the majority of the mollusc species investigated seems to have a wide range of tolerances to different environmental variables (Fig. 3). Cosmopolitan species can tolerate substantial changes in water quality. Accordingly, increasing numbers of cosmopolitan species can signal an increase in levels of human disturbance and pollution (Robert *et al*., 1999).

In the result of the CCA analysis, *D. polymorpha* was cosmopolitan species in the lake (Fig. 3). CCA axes have explained 91.8% of the varience in the species abundance data (Table 3). While it was found Ca and Mg were found the most significant features ($p<0.05$) which respect to species occurence of molluscs, it was also observed temperature, pH, NO_2-N effects the distribution.

CONCLUSION

In this study, a total of 11 mollusca species were determined, 8 belonging to gastropoda and 3 to bivalvia. Water quality in this kind of approach and to know in order to be ecologies of these species will be possible by increasing research. It is suggested to perform detailed studies on each mollusc species in different aquatic ecosystems to obtain the knowledge on effects of environmental variables to species dynamics. Thus, it is increased the knowledge on their using as biological indicator.

ACKNOWLEDGEMENTS

Researcher wish to give his deep thanks to Belgin Camur-Elipek for help in the manuscript. Also thanks is given to Cafer Sahin and Ilgim Sahin for their field asistance. This research was supported by the BAP Project number 2142.

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