African Journal of Biotechnology Vol. 8 (18), pp. 4702-4707, 15 September, 2009
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2009 Academic Journals

Full Length Research Paper

Zoobenthic fauna and seasonal changes of mamasin dam lake (Central part of Turkey)

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Accepted 7 August, 2009

This study was conducted at Mamasın dam lake of Aksaray between April 2002 and March 2003. Seasonal changes in the zoobenthic fauna as well as some physical and chemical parameters of lake were examined based on water samples collected from 4 stations selected in the lake. It was determined that zoobenthic organisms are composed of 86.23% chironomidae, 7.3% oligochaeta and 6.47% mollusca. Four species of chironomidae, 8 of oligochaeta and 5 of mollusca were detected. In respect to faunastic biomass, it was observed that zoobenthic organisms in the lake were maximum in autumn and minimum in spring. Some water quality parameters of 4 stations selected in the lake were measured. The evaluation of the data obtained from the stations and the previous studies revealed that the water quality of Mamasın dam lake is decaying as the pollution builds up and drawing near to the eutrophic level as the indicator species surfaced point out.

Key words: Aksaray, chironomidae, Mamasin dam lake, mollusca, oligochaeta, zoobenthic

INTRODUCTION

The benthic invertebrate animals, which function as an indicator of ecological structure, biological productivity, water quality and pollution at a lake, have a particularly important role in the fresh water ecosystems (Brundin, 1949; Thienemann, 1954; Fittkau and Reiss, 1978). Especially, 3 groups among fresh water benthic invertebrates, oligochaeta (Annelida), chironomidae (Diptera) and gastropoda (Mollusca), occupy an important place. Particularly, chironomidae larvae and oligochaete species from these groups have a great importance and place in the lake's ecosystem, maintaining the aeration, mineralization of mud and at the same time, thwart the purification and provide the required raw material for photosynthesis (Brundin, 1949; Thienemann, 1954; Wilhm, 1975; James, 1979; Fittkau and Reiss, 1986).

In recent years, studies identifying fresh water zoobenthic fauna have increased in Turkey (Ahıska and Karabatak, 1994; Polatdemir and Şahin, 1997; Çapraz and Arslan, 2005; Yıldız et al., 2005; Arslan et al., 2007). However, studies on oligochaeta groups in freshwater lakes are still insufficient. Although some studies on fisheries, water quality, micro and macro fauna were carried out in Mamasın dam lake (İkiz, 1987,1988,1992; Alaş et al., 2005), zoobenthic fauna of the lake has not been studied yet. The aim of this present study is to determine the zoobenthic fauna of the Mamasın dam lake as well as some physical and chemical properties of it and their distribution.

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MATERIALS AND METHODS

Study area

Mamasın dam lake is situated at 17 km distance to the east of Aksaray, which is a central Anatolian province. The dam lake used in drinking and irrigation, which has a 38 m height, 1440 km^2 drainage area and 10 km in length, was built on Melendiz (Uluırmak) stream. There are also some activities of commercial fishery and crayfish production in the lake. The sampling was made on 4 stations with different characteristic (Figure 1).

Station 1: It is near to dam body. It has soil with clay, partly limestone. There is a siltation.
Station 2: It has a bottom with humic and loamy soil. There is a siltation.
Station 3: It is in entering to dam lake of Melendiz and Karasu brooks. It has loamy, humic and sandy soil. There is a siltation.

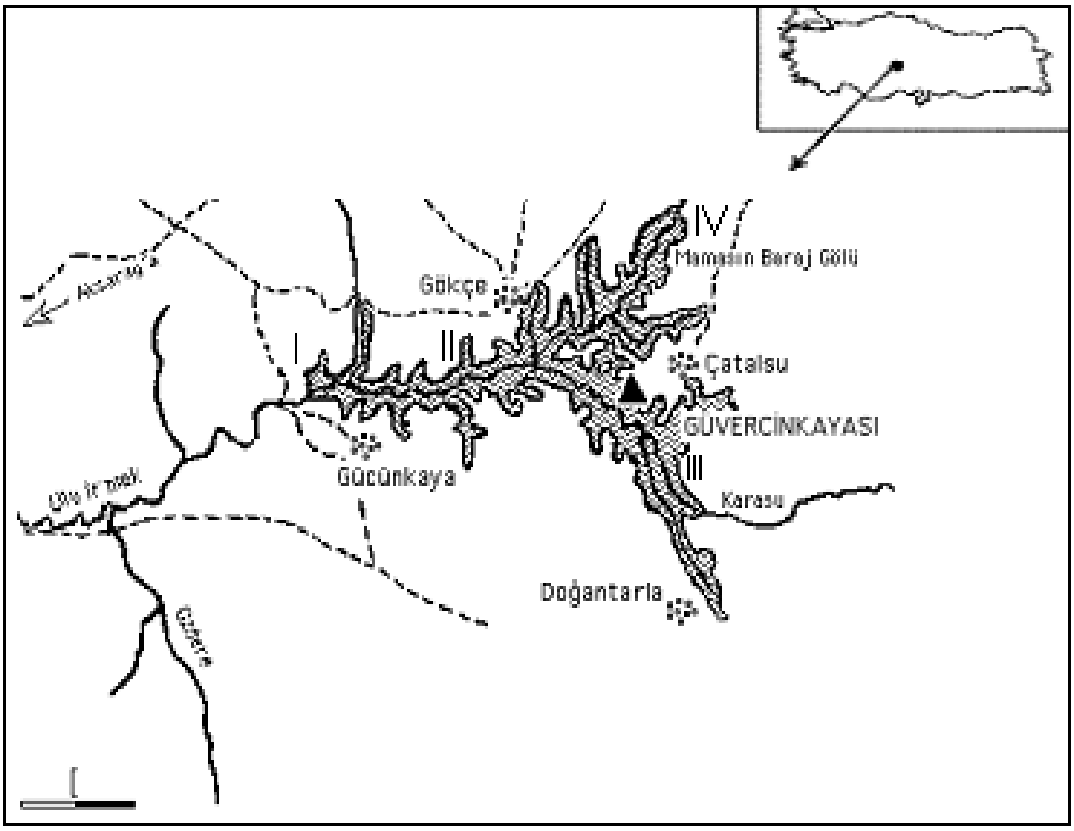

Figure 1. Map of Mamasın dam lake.

Station 4: It is close to Mamasın village. It has soil with clay, loamy and partly limestone. There is a siltation.

Sampling

Water samples

Water samples were collected periodically each month between April 2002 and March 2003 from the selected 4 stations representing all characteristics of the lake and from depths varying from 10 to 30 m by means of an Ekman-Birge mud sampler (Figure 1). Water temperature and dissolved oxygen (DO) were determined by YSI 51 model oxygen meter, the pH value by portable pH meter (WTW 340-A/SET1) and electrical conductivity level by YSI model 33 SCT conductivity meter. Chlorophyll-a was measured with accordance to Youngman (1978). Visibility was measured with a secchi disk and organic substance and total hardness by titration methods in the laboratory (Lind, 1974)

Chemical parameters such as calcium (Ca), magnesium (Mg), bicarbonate (HCO_3), chlorine (Cl), Ammonium (NH_4), Nitrite (NO_2), Nitrate ammonia (NO_2-N), Nitrate (NO_3), nitrate ammonia (NO_3-N) were measured in laboratory (APHA, 1985).

Results of water quality parameters for each station as well as some chemical parameters are given in Table 1.

Zoobenthic samples

Zoobenthic fauna samples were taken at least twice from each station using an Ekman–Birge (15 x 15 cm) grab which has a 225 cm^2 surface area. These samples were sifted by a sieve with a mesh size of 210-3600 µ and fixed with formaldehyde (4%) at the location. Benthic samples fixed with formaldehyde (4%) were identified under binocular microscope. Oligochaete groups were preserved in 70% alcohol and other benthic groups in formaldehyde (4%). Samples were examined qualitatively and quantitatively in accordance with Lagler's (1956) method. Chironomidae larvae were identified according to Şahin (1984, 1991), oligochaete species to Brinkhurst and Jamieson (1971) and Timm (1999) and mollusca ones to Zhadin (1965) and Macan (1977).

RESULTS AND DISCUSSION

At the end of this study, a total of 17 taxa were identified (8 oligochaeta, 4 chironomid, 2 bivalvia and 3 gastropoda). Distributions along with a list of the species recorded were given in Table 2. The findings revealed that zoobenthic structure of Mamasin dam lake is composed of 86.23% chironomidae larvae, 7.3% oligochaeta and 6.4% mollusca species.

With respect to average specimens per square meter, chironomidae larvae were found to be the dominant group (Figure 2). While the third station was the richest (50.10%) in species diversity, the first station was the poorest (4.16%).

Chironomus plumosus (Chironomidae), *Tubifex tubifex* and *Potamothrix bavaricus* (Oligochaeta-tubificidae),

Table 1. Some water quality parameters in Mamasın dam lake.

Parameter	Sampling stations			
	I Min-Max Mean	II Min-Max Mean	III Min-Max Mean	IV Min-Max Mean
Temperature (°C)	4.3 - 23.5 14.6	4.3 - 26.6 14.25	4.7 - 27 15.47	4.5 - 26.9 14.6
Dissolved oxygen (DO) (mg/l)	4.3 - 13.9 8.46	4.86 - 15.9 9.35	4.3 - 15.04 9,36	5.9 - 12.01 9.42
pH	8.6 - 9.78 9.01	8.27 - 9.79 8.88	8.5 - 9.8 9.03	8.4 - 9.8 8.95
Electrical conductivity (µmhos/cm)	433 - 624 541.1	441 - 610 535.7	427 - 607 529.1	439 - 608 531.5
Secchi disk visibility (cm)	60 - 155 88.75	50 - 200 91	25 - 150 73.89	45 - 170 90.5
Organic substance (mg/l)	1.6 - 8.4 3.4	2.2 - 4 2.78	2 - 6 3.15	1 - 4.2 2.72
Total harness FrS	14 - 21 18.11	13 - 22 18.14	14 - 20 17.89	13 - 21 18.08
Ca (mg/l)	28 - 48 39.33	26 -48 37.6	28 - 48 36.89	26 - 48 37.5
Mg (mg/l)	17 - 24 21.22	17 - 27 21.9	16 - 25 21.22	17 - 27 21.9
HCO3 (mg/l)	153 - 268 225.67	159 - 262 223.3	159 - 262 216.44	156 - 268 220.9
Cl (mg/l)	42 - 65 51.1	40 - 63 50.89	41 - 62 50.9	40 - 65 51.89
NH_4 (mg/l)	0 - 0.17 0.06	0.021 - 0.066 0.035	0.006 - 0.171 0.068	0.023 - 0.078 0.05
NO_2 (mg/l)	0.053 - 0,14 0.09	0.039 - 0.125 0.076	0.043 - 0.108 0.078	0 - 0.112 0.065
NO_2-N (mg/l)	0.02 - 0.04 0.03	0.012 - 0.038 0.023	0.013 - 0.033 0.024	0 - 0.034 0.020
NO_3 (mg/l)	3.57 - 7.71 5.25	2.768 - 8.104 5.01	2.006 - 8,37 5.35	2.569 - 7.772 4.48
NO_3-N (mg/l)	0.81 - 1.39 0.97	0.625 - 1.83 1.22	0.585 - 1.89 1.23	0.58 - 1.755 1.09

Physa acuta and *Gyraulus albus* (Gastropoda*)* were recognized as the most widely available species in the study area. All of these species, especially tubificidae and chironomidae members, are known to live in a range of water bodies, including eutrophic waters.

C. plumosus, which was determined as a dominant species of chironomidae, is a eutrophic species and it was reported that it exists in every kind of fresh water systems (Armitage et al., 1995).

As we have expressed previously, the density of chironomidae members is ascertained to be 86.23%, and the number of chironomidae larvae per square meter noticeably increased, particularly in October and January (Figure 2).

Within the recognized zoobenthic organisms, chironomidae are followed by oligochaeata in terms of density with a proportion of 7.3%. The species *Dero digitata* from naididae, *T. tubitex*, *Limnodrilus hoffmeisteri*, *Limnodrilus claparedeianus*, *Limnodrilus udekemianus*, *Limnodrilus* sp., *Potamothrix bavaricus*, *Psammoryctides deserticula* from the family tubificidae, all belonging to the oligochaeate group, was spotted. These organisms were found out to be the densest (644 BS/m^2) in April; the least density (22 BS/m^2) is in May.

Among the species spotted at the lake, *Limnodrilis* and *Tubifex*, which are members of oligochaeta group are

Table 2. Taxonomic situations of zoobenthic groups in Mamasın dam lake.

Class	Family		Species (Taxa)
Gastropoda	Physidae	1	*P. acuta* Drap., 1805
	Planorbidae	2	*P. planorbis* Linn., 1758
		3	*G. albus* Müller, 1774
Bivalvia	Sphaeriidae	4	*Sphaerium lacustre* Müller, 1774
		5	*Pisidium casertanum* Poli, 1791
Oligochaeta	Naidinae	6	*D. digitata* (Müller, 1773)
	Tubificinae	7	*T. tubifex* (Müller, 1774)
		8	*L. hoffmeister* Claparéde, 1862
		9	*L. claparedeianus* Ratzel, 1868
		10	*L. udekemianus* Claparéde, 1862
		11	*Limnodrilus* sp.
		12	*Potamothrix bavaricus* (Öschmann, 1913)
		13	*Psammoryctides deserticula* (Grimm, 1877)
Insecta	Chironomidae	14	*Procladius (Holotanypus)* sp.
		15	*Chironomus plumosus* (Linnaeus, 1758)
		16	*C. anthracinus* (Zetterstedt, 1860)
		17	*Polypedilum nubeculosum* (Meigen, 1804)

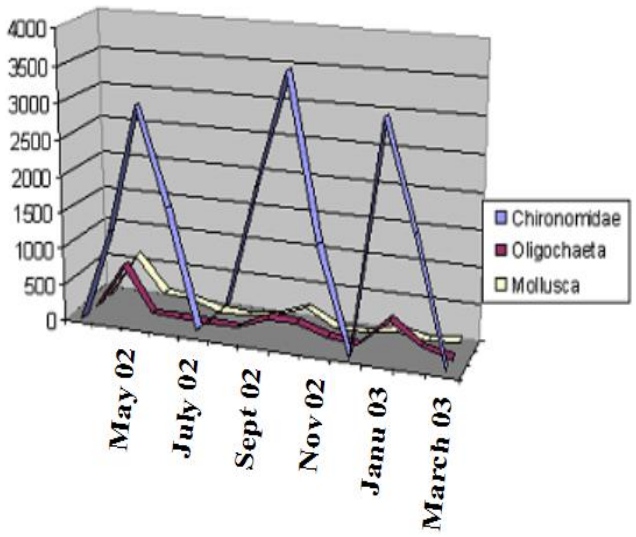

Figure 2. Average numbers (BS/m^2) of chironomidae, oligochaeta and mollusca for each month in Mamasın dam lake.

considered cosmopolitan and it is known that especially *T. tubifex* can live in every kind of water surroundings (Brinkhurst and Jamieson, 1971).

During the study, mollusc species were found to be the least dense (6.47%) among zoobenthic organism groups. The species *Sphaerium lacustre* and *Pisidium casertanum* belonging to sphaeriidae family, *Physa acuta* belonging to the family physidae and *Planorbis planorbis*, *Gyraulus albus* belonging to the family planorbidae were identified. These organisms were found out to be the densest (644 BS/m^2) in April, and the least density in February.

In a study carried out by Şahin and Baysal (1972) in lake Hazar on the lake's zoobenthic fauna and its distribution, it was recorded that the lake's zoobenthic fauna was composed of oligochaeta (75.48%), chironomidae larvae (17.89%) and other groups (2.63%) except for mollusca. In addition, as getting deeper into the Lake, they found an increase in the number of oligochaeta. They indicated that this situation is related with the structure of the lake's base rather than the depth, that is, surviving in the firmer muddy biotopes is more difficult for them (Şahin and Baysal, 1972). This case in Hazar Lake seems to be similar to those in Mamasın dam lake.

C. plumosus, *C. anthracinus*, *T. tubifex* and *Lumbriculus* species were detected by Geldiay and Tareen (1972) from Gölcük lake, which is a eutrophic lake. We found these species in Mamasın dam lake. The fact that *C. plumosus* was found as the most densely available species in Gölcük lake is also consistent with our findings.

C. plumosus, *Physa* sp., *Planorbis* sp., *Lymnaea* sp., *Pisidium* sp. and *Tubifex* sp. had been discovered by Sözen and Yiğit (1996) in the Akşehir lake, which possesses a eutrophic character. In this study, the same species were also identified in Mamasın dam lake. Besides, it was reported that while chironomid larvae were the most widely (51.55 %) available species, oligochaeta is in the second level (45.97 %) in the lake Akşehir (Sözen and Yiğit, 1996). Consequently, it can also be stated that the results of Mamasın dam lake study are similar to the findings of Sözen and Yiğit (1996).

Table 3. Chlorophyll-a value (µg/l) in Mamasın dam lake

Station	Months											
	A	M	J	J	A	S	O	N	D	J	F	M
I	11.804	6.949	4.855	17	**	69.36	12.947	47.6	13.9	13.232	*	13.423
II	7.806	6.949	26.928	20.4	**	30.029	13.654	62.07	19.37	13.99	**	8.282
III	7.235	10.472	31.008	63.65	**	8.922	25.132	**	24.85	15.8	**	*
IV	13.994	8.806	18.237	43.09	**	16.32	9.465	**	29.13	16.95	**	17.992
Mean	10.21	8.294	20.257	36.03	**	31.158	15.3	54.84	21.81	14.99	**	13.232

*Not measured.
**Not sampled.

Fındık (2000) also reached results consistent with our findings, since the dominant groups were reported by Fındık (2000) as chironomidae larvae (52.77%) and oligochaeata species (47.23%) in Berdan dam lake. In addition, *Dero digitata, Potamothrix bavaricus*, *L. hoffmeisteri*, *C. plumosus, C. anthracinus* species determined in the present study in Mamasın dam lake were listed by Fındık (2000) in their study.

In a macrobenthic fauna study in Gölmarmara lake, which also possesses a eutrophic character, *C. plumosus* (68%) was determined as the dominant species (Taşkıran, 2002). This species was also found in the lake Mamasın each month. Furthermore in both lakes, *C. plumosus* peaked in October. The invertebrate and vertebrate predator pressure and delayed rising of water temperature were reported as the causes of the monthly varying in the distribution of chironomid and oligochate in Eğrigöl lake (Yıldız et al., 2005).

In most cases, it can be said that the concentration of Oligochaete and chironomidae groups in the lakes is associated with the physical and chemical properties of water and sediment structure in the lakes.

The varying of benthic fauna groups' numbers or proportions according to different stations, seasons and years, are linked to different biological and ecological properties of them. It can be hypothesized that the decrease in the number of oligochaeta and chironomidae larvae species in summer months is resulted from the predator pressure and to the increase in larva flights as species reach adult stages. While the proportion of chironomidae larvae was 80% and that of oligochaeta was 10% in Mogan lake, which is a eutrophic lake, these ratios were found to be 24.66% for chironomidae and 74.65% for oligochaeta in Uluabat lake, which also possesses a eutrophic character (Tanyolaç and Karabatak, 1974; Kırgız and Soylu, 1975). A recent study reported these ratios as 35.6% for oligochaeta and 12.3% for chironomidae (Kökmen et al., 2007).

In upper part of the Sakarya River, *G. albus*, *Physa acuta,* and *Valvata cristata* from gastropoda had been found as the most widely available species (Çabuk et al., 2004). These species were reported as indicators of organic pollution and also *G. albus* was recorded by Gallordo et. al., (1994) from polluted waters. These findings are consistent with our results.

In this study, in Mamasın dam lake, water temperature was found to vary between 4.30°C in December and 26.9°C in July. Indirectly causing the varying in viscosity and concentration in aquatic systems, water temperature has an effect on growth and distribution of zoobenthic species. Dissolved oxygen (DO) is the most important chemical in aquatic systems. The level of the dissolved oxygen diminishes as a result of respiration of living organisms and decomposition of organic matters in water systems. The increase of water temperature also causes the diminution of oxygen solubility. Minimum and maximum DO values measured were 4.30 mg/l in July and 15.90 mg/l in January. Temperature and DO values detected in Mamasın dam lake were in the acceptable range for the surviving of aquatic life.

An important parameter of aquatic ecosystems is also pH. pH values change from 6 to 9 in unpolluted lakes. Mollusc species do not inhabit acidic lakes. Much of invertebrates have tolerate to a wide range of pH. In this study, pH values varied during a year. A minimum value of pH was 8.27 in January, while maximum one was 9.80 in May. Electrical conductivity (µmhos/cm) considered as total quantity of solid mass was found to be 427 µS/cm in May in minimum and 624 µS/cm in October in maximum. EC value was lightly found over mean values in Mamasın dam lake. Chlorophyll-a value increased based on increasing secchi disk visibility (cm), photosynthesis and accumulation of organic substrate. Chlorophyll-a value was 4.85 µ/l in June in minimum and while 69.3685 µ/l in September in maximum (Table 3). Secchi disk visibility (cm) used to determine light permeability was measured to be a minimum value of 25 cm in April and October and a maximum of 200 cm in July. Other parameters measured in the lake were not in aspect restricting living things.

Lakes, in which secchi disk value and a chlorophyll-a are 0.8-1.5 m and of 2.7-78.0 µg/l within trophic classifycation system based on limit values of OECD, respecttively are evaluated as eutrophic lakes (Ryding and Rast, 1989). In the basis of these values, although mamasın dam lake is deep (38 m in maximum), light permeability was found to be 86.03 cm in annual average and chlorophyll-a 22.61 µg/l. In this lake, however, benthic

fauna had less species, number of individual was high (1965.5 Bs/m^2). It has been reported that *D. digitata*, which was also spotted in this study, can be found particularly in the eutrophic areas and it is affected positively from the increase of organic matter (Särkkä, 1989). *C. plumosus* and *T. tubifex*, which are an indicator of eutrophication were dominant species. These findings showed that Mamasın dam lake is an eutrophic lake.

Finally, removing water from the lake for irrigation purposes and evaporation during summer season effect some different ecological conditions and consequently, lead to the acceleration of eutrophication. So, water quality of the lake is being ruined day by day. Indeed, the lake already exhibits the eutrophic lake characteristics. Accordingly, preventive measures must be put into action urgently for recovering the water quality at Mamasın dam lake.

ACKNOWLEDGEMENT

The authors gratefully for determination of Oligochaetae with the assistance of Dr. Seray Yildiz.

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