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The Seasonal Variations of Algae in Korpinar Pond (Elazig/Turkey)

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Abstract: Samples of algae living in Korpinar pond were collected from September 2008 to August 2009 and examined. Sampling was performed monthly. Some physical and chemical characteristics of the pond were measured throughout the duration of the study. The high chlorophyll a value and widespread presence of some macroscopic aqueous plants in the pond suggested that the concerned pond had a eutrophic character. Of the 60 taxa identified during the study, 42 were found to belong to Bacillariophyta division, 9 to Chlorophyta, 6 to Cyanophyta, 2 to Dinophyta and 1 to Euglenophyta division. The seasonal variations in these algae were examined together with their physical and chemical characteristics and the results of this examination were compared with the results of previous studies carried out in ponds.

Key words: Korpinar pond, algae, epilithon, epipelon, plankton, seasonal variation, Elazig

INTRODUCTION

Due to their unique properties, algae have great importance for surface waters. Being the basic source of oxygen for the living things in water and water sources as well as the first and major loop in the food chain, they have also been put to significant uses for human food and health in recent years. Algae and water quality in rivers, lake basins and ponds have been studied in the country (Unal, 1984, 1995; Dere, 1989; Yildiz and Baykal, 1995, 1996; Atici and Obali, 1999; Gurbuz and Altuner, 2000; Gurbuz, 2000; Baykal and Akbulut, 1999; Sen *et al*., 2001; Gurbuz *et al*., 2002a, b; Cirik and Somek, 2003; Demir *et al*., 2007; Ozer and Pala, 2009; Gumus and Gonulol, 2010; Pursunlerli, 1994).

Recently, there has been an increase in the number of studies into ways of obtaining natural vitamins from algae. Another reason why algae are studied is the fact that they can be produced easily and inexpensively in culture media.

In order to identify the algae that grow in the pond environment, Korpinar pond algae have been examined together with the physical and chemical factors that affect the development of algae and the results were compared with the results of the studies carried out in the pond environment in the country.

MATERIALS AND METHODS

Algae and water quality in Korpinar pond have been investigated for 1 year from September 2008 to August 2009 using monthly samplings. Korpinar pond is on the 25 km of the Elazig-Keban highway (Fig. 1 and 2). The surface area of the pond is 60 m^2 and average depth is 2 m. This water source which has been used for drinking water was blocked to create a small pond to be used for irrigation purposes.

Fig. 1: The map of Korpinar pond

Following the creation of the pond, algae and macrophytes which spread diffusely in all environments have formed the flora of the pond. Surface water temperature of the Korpinar pond was measured using a mercury thermometer with 1°C divisions and pH and dissolved O_2 values with Hanna 91410 model pH/O_2 meter in the field while Nitrate (NO_3), orthophosphate (PO_4) and Silicate (SiO_2) values were determined using Spectrophotometric method (APHA, 1985). Plankton samples were collected by sweeping the entire pond surface with a plankton net, epipelic algae were collected from mud samples and epilithic algae were scraped from stones. Epilithic samples were washed in sterile water and put into sterile plastic bags. The mud containing epipelic samples were placed into Petri dishes in the laboratory and the dishes were covered with gauze. The samples

Fig. 2: Korpinar pond

were watered with pure water on a daily basis and algae were made to cling to the gauze using their heliotropic nature. After several days, the gauze was washed with pure water and placed into an Erlenmeyer flask. While algae other than the planktonic, epipelic and epilithic diatoms were examined in transient preparations, continuous preparations were made for diatoms. Nikon brand microscope and relevant identification books were used in the species identification and counts of diatoms whose continuous preparations have been made and other algae in transient preparations (Whitton *et al*., 2002). The counts in continuous preparations were based on relative density and the results were expressed as organism (%) (Sladeckova, 1962).

RESULTS AND DISCUSSION

In order to determine some physical and chemical properties of the Korpinar pond, some physical measurements have been carried out in the field and chemical analyses were conducted in the laboratory between September 2008 and August 2009 and the results have been shown in Table 1 and 2.

The highest surface water temperature in the pond throughout the study period (26°C) was recorded in August and the lowest surface water temperature (8.3°C) was recorded in February. The highest pH values in the

Table 1: Variations in values of physical and chemical parameters in Korpinar pond

	Parameters						
Date	Water temp (°C)	pH	Dissolved oxygen (mg L^{-1})	Electrical conductivity (µS cm^{-1})	Dissolved total solid matter (mg L^{-1})	Total hardness (mg $CaCO_3$ L^{-1})	Organic matter (mg O_2 L^{-1})
Sep. 2008	24.0	7.2	8.0	450	230	210	9.0
Oct. 2008	15.0	7.7	9.0	430	240	180	8.0
Nov. 2008	13.0	8.6	10.0	420	200	140	3.0
Dec. 2008	10.0	7.3	11.0	460	180	150	4.0
Jan. 2009	9.0	8.2	12.0	480	230	180	4.5
Feb. 2009	8.3	8.5	11.3	510	240	190	5.0
Mar. 2009	10.0	8.4	12.0	520	250	160	3.0
Apr. 2009	16.0	7.8	13.0	530	260	150	2.0
May 2009	18.0	8.6	14.0	490	230	170	5.0
Jun. 2009	20.0	7.6	10.0	450	200	190	6.0
Jul. 2009	24.0	8.9	9.0	380	170	220	7.5
Aug. 2009	26.0	8.6	8.0	400	180	200	8.5

Table 2: Variations in values of chemical parameters in Korpinar pond

	Parameters					
Date	Silica (mg L^{-1})	Nitrate (mg L^{-1})	Sulpate (mg L^{-1})	Total phosphorus (mg L^{-1})	Total nitrogen (mg L^{-1})	Chlorophyll a (mg L^{-1})
Sep. 2008	2.4	40.58	51.24	0.05	1.8	5.2
Oct. 2008	2.1	38.54	48.56	0.04	1.2	5.0
Nov. 2008	1.8	32.45	52.45	0.04	1.4	4.8
Dec. 2008	1.6	30.20	47.25	0.03	2.3	4.2
Jan. 2009	1.2	33.25	40.84	0.02	2.6	3.6
Feb. 2009	0.8	32.24	38.56	0.05	3.2	2.7
Mar. 2009	0.6	30.16	27.85	0.08	3.5	5.6
Apr. 2009	0.4	28.78	11.79	0.10	4.3	4.2
May 2009	0.7	32.92	12.58	0.09	4.8	4.3
Jun. 2009	2.1	36.24	24.46	0.08	4.6	6.1
Jul. 2009	2.3	38.45	32.48	0.07	3.8	5.8
Aug. 2009	2.5	45.56	46.42	0.08	2.4	5.0

Pond (Gurbuz, 2000; Baykal and Akbulut, 1999) were found in July and the lowest (Gurbuz and Altuner, 2000; Dere, 1989) in September. The highest dissolved oxygen values in Korpinar pond (11.3 mg O_2 L^{-1}) were established in February and the lowest values (8 mg O_2 L^{-1}) in August and September (Table 2).

The highest electrical conductivity (530 μS cm^{-1}) was recorded in April and the lowest electrical conductivity (380 μS cm^{-1}) in July while the highest TDS values (260 mg L^{-1}) were found in April and the lowest (170 mg L^{-1}) in July (Table 1).

Total hardness values of the pond water over the study period were the highest in July (220 mg $CaCO_3$ L^{-1}) and the lowest in October (140 mg $CaCO_3$ L^{-1}) as for the organic substance values, these were found highest (9 mg O_2 L^{-1}) in September and lowest (2 mg O_2 L^{-1}) in April (Table 1).

The highest silica values (2.5 mg L^{-1}) were established in August and the lowest values (0.4 mg L^{-1}) in April. Nitrate levels in the pond over the study period ranged between the highest values (45.56 mg L^{-1}) in August and the lowest values (28.78 mg L^{-1}) in April. As for sulfate values, the highest values (52.45 mg L^{-1}) were found in November and the lowest (11.79 mg L^{-1}) in April. Total phosphate values in the study were the highest in April (0.1 mg L^{-1}) and the lowest in January (0.02 mg L^{-1}). The highest total nitrogen values (4.8 mg L^{-1}) were found in May and the lowest total nitrogen values (1.2 mg L^{-1}) in October. Chlorophyll a values were the highest (6.1 mg L^{-1}) in June and the lowest (2.7 mg L^{-1}) in February (Table 2).

Of the 60 taxa identified throughout the study, 42 were found to belong to the Bacillariophyta division, 9 to the Chlorophyta division, 6 to the Cyanophyta division, 2 to the Dinophyta division and 1 was found to belong to the Euglenophyta division. Bacillariphyta were represented by 25 taxa, Chlorophyta by 6 taxa, Cyanophyta by 5 taxa, Dinophyta by 2 taxa and Euglanophyta by 1 taxon. The list of the alga species identified in Korpinar pond is shown in Table 3. Among the diatoms, pennate diatoms were recorded to have a higher number of taxa than centric diatoms and the genera with the highest number of taxa were found to be Cymbella and Navicula with 5 taxa in each and Diatoma, Gomphonema and Nitzschia with 3 taxa in each.

Among the diatoms identified in Korpinar pond, the most marked ones in terms of their relative density were *Cymbella affinis*, *Fragilaria construens* (Max. 36% August-Min. 6% February) and *Gomphonema truncatum* var. *capitatum* (Fig. 3). Of the epilithic diatoms established in the pond over the study period, *Cymbella affinis*, *Diatoma vulgare* and *Navicula cryptocephala* were the ones with the highest relative density and were remarkable due to their common occurrence (Fig. 4).

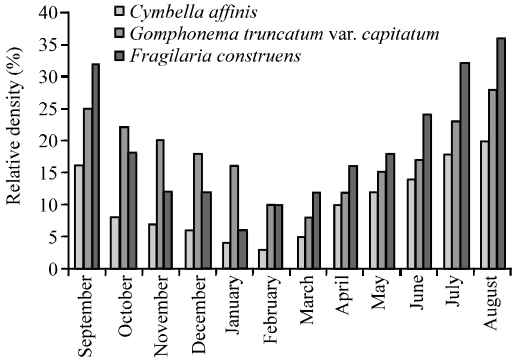

Fig. 3: Seasonal variations in the relative density of planktonic diatoms in the Korpinar pond

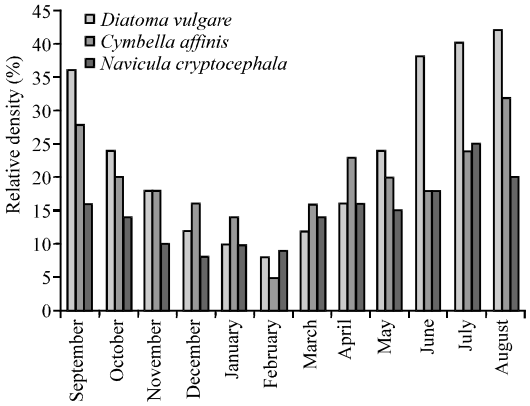

Fig. 4: Seasonal variations in the relative density of epilithic diatoms in the Korpinar pond

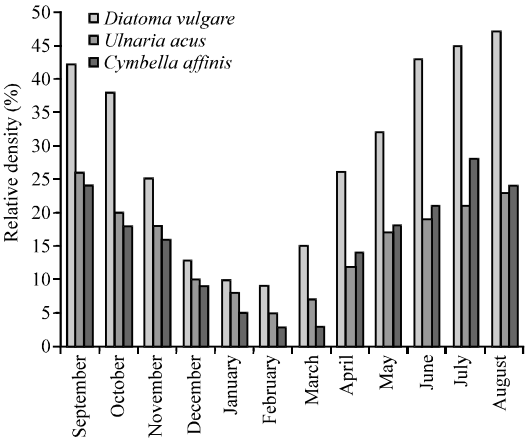

Fig. 5: Seasonal variations in the relative density of epipelic diatoms in the Korpinar pond

Cymbella affinis, *Diatoma vulgare* and *Ulnaria acus* were the most common epipelic diatoms of the Korpinar pond and had relative densities greater than other diatoms (Fig. 5).

Table 3: The algae of Korpinar pond

Taxa of alga	Plankton	Epilithon	Epipelon
Bacillariophyta			
Centrales			
Aulacoseira granulata (Ehrenberg) Simonsen	+	+	+
Cyclotella kutzingiana Thwaites	-	+	+
Cyclotella radiosa (Grunow in van Heurck) Lemmermann	-	+	+
Pennales			
Achnanthidium minutissimum (Kutzing) Czarnecki	+	+	+
Amphora ovalis (Kutzing) Kutzing	+	-	+
Cocconeis placentula Ehrenberg	+	+	+
Craticula ambigua (Ehrenberg) D.G. Mann	+	+	+
Ctenophora pulchella (Ralfs ex Kutzing) D.M. Williams and Round	-	+	+
Cymatopleura solea (Brebisson) W. Smith	-	+	+
Cymbella affinis Kutzing	+	+	+
Cymbella cuspidata Kutzing	+	+	+
Cymbella leptoceros (Ehrenberg) Kutzing	+	+	+
Cymbella helvetica Kutzing	+	+	+
Cymbella tumida (Brebisson) Van Heurck	+	+	+
Diatoma elongatum (Lyngbye) C. Agardh	+	+	+
Diatoma tenue C. Agardh	+	+	+
Diatoma vulgaris Bory	+	+	+
Encyonema triangulum (Ehrenberg) Kutzing	+	+	+
Fragilaria construens (Ehrenberg) Grunow	+	+	+
Gomphonema intricatum Kutzing	+	+	+
Gomphonema productum (Grunow) Lange-Bertalot and Reichardt	+	+	+
Gomphonema truncatum var. *capitatum* (Ehr.) Patr. nom. nov.	+	+	+
Gyrosigma acuminatum (Kutzing) Rabenhorst	+	+	+
Halamphora veneta (Kutzing) Levkov	+	+	+
Hantzschia amphioxys (Ehrenberg) Grunow	+	-	-
Mastogloia smithii Thwaites ex W. Smith	+	+	+
Navicula cincta (Ehrenberg) Ralfs	+	+	+
Navicula cryptocephala Kutzing	+	+	+
Navicula reinhardtii Grunow	+	+	+
Navicula salinarum Grunow	+	+	+
Navicula viridula (Kutzing) Ehrenberg	+	+	+
Nitzschia amphibia Grunow	+	+	+
Nitzschia linearis (C. Agardh) W. Smith	+	+	+
Nitzschia sigmoidea (Nitzsch) W. Smith	+	+	+
Pinnularia viridis (Nitzsch) Ehrenberg	+	-	-
Rhoicosphenia abbreviata (C. Agardh) Lange-Bertalot	+	+	+
Rhopalodia gibba (Ehrenberg) O. Muller	+	+	+
Sellaphora pupula (Kutzing) Mereschkovsky	+	+	+
Surirella minuta Brebisson	+	+	+
Surirella moelleriana Grunow	+	+	+
Ulnaria acus (Kutzing) M. Aboal	+	+	+
Ulnaria ulna (Nitzsch) P. Compere	+	+	+
Chlorophyta			
Coelastrum microporum Nageli	+	-	-
Cosmarium botrytis var. *tumidum* Wolle	+	-	-
Pediastrum boryanum (Turpin) Meneghini	+	-	-
Pediastrum boryanum var. *cornutum* (Raciborski) Sulek	+	-	-
Scenedesmus obtusus Meyen	+	-	-
Scenedesmus subspicatus Chodat	+	-	-
Scenedesmus verrucosus Y.V. Roll	+	-	-
Spirogyra fluvatilis Hisle in Rabenhorst	+	-	-
Zygnema insigne (Hassal) Kutzing	+	-	-
Cyanophyta			
Merismopedia glauca (Ehrenberg) Kutzing	+	-	-
Oscillatoria limosa C. Agardh ex Gomont	+	-	-
Oscillatoria redekei Goor	+	-	-
Phormidium limosum (Dillwyn) P.C. Silva	+	-	-
Pseudoanabaena limnetica (Lemmermann) Komarek	+	-	-
Spirulina major Kutzing ex Gomont	+	-	-
Dinophyta			
Ceratium hirundinella (O.F. Muller) Dujardin	+	-	-
Peridinium bipes F. Stein	+	-	-
Euglenophyta			
Euglena deses Ehrenberg	+	-	-

Apart from the diatoms identified over the study period in Korpinar pond, *Pediastrum boryanum* and *Scenedemus obtusus* of Chlorophyta as well as *Oscillatoria limosa* and *O. redekei* of Cyanophyta appeared on planktons and were particularly noteworthy in autumn and winter months. *Peridinium bipes* of Dinophyta and *Euglena deses* of Euglenophyta on the other hand, emerged on planktons in late summer and early autumn but proved ineffective.

Algae in Korpinar pond were examined between September 2008 and August 2009 and the results were compared with the results of previous algae studies carried out in ponds in Turkey. Of the 60 taxa identified over the study period, 42 belonged to Bacillariophyta division, 9 to Chlorophyta, 6 to Cyanophyta, 2 to Dinophyta and 1 to Euglenophyta.

In TMI12 pond, a total of 40 taxa were established and of these, 3 were centrales and 37 were pennales Bacillariophyta (Ozer and Pala, 2009).

Sen *et al.* (2001) who carried out their study in Tadim pond recorded a total of 29 taxa and reported that of these 29 and 28 were in benthic and 14 in pelagic form and that of the diatoms, 5 were centric and 24 were pennate.

The fact that some diatom taxa are found only in a single community demonstrates that these diatoms enjoy specific occurrence characteristics. Since, the majority of alga taxa showed specific characteristics by occurring in one or two samples throughout the study, it may be misleading to generalize the selective properties that algae display when they occur. It is a well known fact that the determination of the specific characteristics that algae display when they emerge requires long and laborious research efforts.

Some of the diatoms recorded in the pond on Sulucayir plain (TMI12) were remarkable for their being phytobenthos. In the concerned study, *Eunotia minor*, *Gomphonema constrictum* and *Navicula bacillum* were recorded only in their benthic forms (Ozer and Pala, 2009).

In their study carried out in the Tadim pond, Sen *et al.* (2001) recorded *Stephanodiscus dubius*, *Achnanthes exigua*, *A. affinis*, *A. minutissima*, *Amphora normanii*, *Cocconeis placentula* var. *lineata*, *Fragilaria brevistriata*, *Fragilaria construens*, *Gomphonema constrictum* var. *capitata*, *G. olivaceum*, *G. truncatum* var. *capitatum*, *Navicula cuspidata*, *N. radiosa*, *Neidium affine* and *Nitzschia linearis* only in benthic forms.

Among the diatoms identified in Korpinar pond over the study period, *Cyclotella kutzingiana*, *Cyclotella radiosa*, *Ctenophora pulchella* and *Cymatopleura solea* were recorded only in benthic form and *Pinnullaria viridis* only in planktonic form.

Moss (1980) stated that *Navicula* and *Nitzschia* species were cosmopolite. It has been reported in various studies (Unal, 1984, 1995; Dere, 1989; Yildiz and Baykal, 1995, 1996; Atici and Obali, 1999; Gurbuz and Altuner, 2000; Gurbuz, 2000; Baykal and Akbulut, 1999; Sen *et al.*, 2001; Gurbuz *et al.*, 2002a, b; Cirik and Somek, 2003; Demir *et al.*, 2007; Ozer and Pala, 2009; Gumus and Gonulol, 2010; Pursunlerli, 1994) carried out in the country that *Navicula* and *Nitzschia* species are commonly found. The fact that the species *Navicula* and *Nitzschia* were established in all habitats in the study supports the idea that the species belonging to these genera are cosmopolite.

Cox (1984) and Wetzel (1983) argued that light was the major factor in the seasonal distribution of algae while Round (1953, 1981) noted that algae grew better in the phytoplankton in spring and early summer and less in the period between July and October. Besides, Lund (1950) highlighted temperature and light as the major factors that affected the development of algae.

The richness and the number of individual members of algae species were seen to vary seasonally in the present study. Summer was the season in which species composition of algae in the pond was the richest and winter was when the composition was the poorest. This suggests that the water temperature and intensity of light affect the composition and reproduction of algae.

Although, several diatoms registered in Korpinar pond were insignificant in terms of their frequency of occurrence among epilithic algae communities, they were noteworthy due to their high relative density in certain months. This finding suggests that there may be a succession among diatoms as long as conditions permit.

CONCLUSION

When the continuous presence of diatoms in the epilithic algae communities is considered, it appears that diatoms are cosmopolitan can be among the most commonly encountered algae in all types of substrata and may be used as biological monitors (Wetzel, 1983; Round, 1953).

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