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Phytoplankton Diversity and Nutrients at the Jajerood River in Iran

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Abstract: Jajerood river is one of the freshwater river in Iran. Seasonal changes in phytoplankton composition and physico-chemical factors affecting these parameters were investigated in this study. Qualitative phytoplankton and nutrient analysis were carried out between 2005 and 2006 at 19 sampling stations of Jajerood, situated in the north-eastern of Tehran. A total of 53 taxa were determined, belonging to four algae classes: *Bacillariophyceae*, *Chlorophyceae*, *Cyanophyceae* and *Dinophyceae*. *Bacillariphyceae* appeared to be the dominant group in terms of total genus number during the study period. The number of phytoplankton genus was high in summer and quite low in winter. The highest phytoplankton diversity determined in summer was due to the increase in the numerical of *Cymbella* from the diatoms. Phytoplankton diversity declined to the lowest level in the winter. The lowest and highest concentration of NO_3 and PO_4 were 1.9 and 8.5 $\mu g\ L^{-1}$ and 0.05 and 0.76 $\mu g\ L^{-1}$, respectively.

key words: Phytoplankton, genus composition, diversity, nutrients, Jajerood river

INTRODUCTION

Algae are the major primary producers in many aquatic systems and are an important food source for other organisms. Genus composition and the seasonal variations of these forms in freshwater are dependent on the interactions between physical and chemical factors. Therefore, phytoplankton genus and diversity fluctuate according to the seasons. It has been shown that many of these fluctuations, called seasonal successions, could result from the life activities of the previously existing phytoplanktons and zooplanktons, fishes and other organisms (Sommer *et al*., 1986). The seasonal succession of the phytoplankton is a problem that has attracted the attention of algologists for a long time, but many of the studies on periodicity have been restricted to limited areas. Unfortunately, there are a few studies carried out on the phytoplankton succession and composition in Jajrood. The first phytoplankton study in the region was carried out by Shadkam (2005). No attempts have been made to explain the seasonal development of phytoplanktons in this river. However, there is inadequate information on the seasonal distribution of the freshwater phytoplanktons in Iran. Therefore, this study was carried out to investigate the composition diversity and to study the nutrients and physico-chemical and their impacts on the diversity of the phytoplankton by seasonal samplings in the Jajerood river.

MATERIALS AND METHODS

The study was carried out in the coastal area of Jajerood, Nineteen sampling stations were selected in the area. Phytoplankton and water samples were taken from a 0-25 cm water column seasonally from the stations between March 2005 and January 2006, using 1.5 l PVC-bottles water samplers. At each station sampling was done under ice. For each sampling station two PVC-bottles (500 mL, for qualitative and quantitative analysis) were filled. The samples for qualitative analyses were preserved in 4% formaldehyde solution immediately after collection. Later on in the laboratory the preserved samples were left to stand for 24 h in order to achieve sedimentation of the algal cells. After sedimentation the samples were concentrated first to 50 mL by carefully removing 450 mL through aquarium tubes. The remaining 50 mL were centrifuged for 20 s at 4000 rpm. The liquid phase was then immediately removed and the remaining pellet re suspended in approximately 10 drops of sample water with a Pasteur pipette. When the exact identification of genus proved impossible from the preserved samples, fresh samples were used for assistance. Dissolved oxygen concentration, temperature and pH were measured with a combined electrode (Multi 340 i model) in situation. Total Nitrate-Nitrogen and Phosphate concentrations of the river water were determined in the laboratory (Moopam, 1999). Phytoplankton individuals were observed using a

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Nikon E200 microscope with Normarski interference optics. The phytoplankton was identified mainly using the works of Desikachary (1959), Thienemann (1962), Tiffany and Britton (1952) and Prescott (1982).

RESULTS

Physico-chemical factors: Seasonal changes in temperature in different sampling stations are shown in Table 1.

The lowest temperature (6.7°C) was recorded in winter, whereas the highest, in summer, was 27°C.

Dissolved oxygen changes in different sampling stations are shown in Table 2.

The lowest dissolved oxygen (0.02 mg L^{-1}) was recorded in spring, whereas the highest, in autumn, was 18.45 mg L^{-1}.

Table 1: Seasonal changes in surface water temperature at sampling stations

Stations	Winter temperature	Spring temperature	Summer temperature	Autumn temperature
1	6.70	10	17.0	8.0
2	9.95	10	14.0	8.3
3	7.05	8	13.0	10.2
4	10.20	12	16.0	9.4
5	9.95	13	16.0	11.1
6	10.80	14	17.0	10.5
7	9.95	14	14.0	9.3
8	10.50	16	17.0	11.0
9	8.00	13	20.0	13.0
10	12.00	15	16.5	10.0
11	8.55	13	20.0	12.0
12	9.95	15	20.0	13.0
13	10.20	15	20.0	13.0
14	12.25	13	22.5	13.0
15	10.85	15	22.0	12.5
16	12.45	14	21.0	12.0
17	12.70	16	22.0	13.0
18	12.70	18	23.0	12.0
19	14.80	19	27.0	14.0

Table 2: Seasonal changes in surface water dissolved oxygen at sampling stations

Stations	O_2 Winter	O_2 Spring	O_2 Summer	O_2 Autumn
1	7.64	0.04	4.97	6.26
2	8.06	0.69	6.49	7.53
3	7.13	0.14	6.26	5.98
4	6.94	0.29	3.13	7.05
5	7.62	0.05	8.05	6.25
6	6.84	0.29	5.42	7.31
7	8.27	0.02	6.24	7.83
8	7.92	0.02	6.50	7.44
9	7.38	0.22	5.31	7.51
10	7.53	0.05	5.59	8.60
11	8.89	0.02	4.82	9.99
12	8.25	0.07	14.38	5.18
13	7.61	0.02	7.49	7.50
14	7.90	0.05	5.22	6.10
15	8.17	0.04	6.01	12.87
16	8.04	0.08	6.47	9.12
17	8.06	0.02	4.57	15.40
18	7.62	0.15	4.66	18.45
19	7.2	0.09	5.36	9.26

Table 3: Seasonal changes in surface water pH at sampling stations

Stations	Winter pH	Spring pH	Summer pH	Autumn pH
1	8.18	7.80	8.06	6.81
2	7.78	8.00	8.44	5.65
3	7.97	8.25	8.21	5.56
4	8.21	8.22	8.47	6.77
5	7.52	8.27	8.33	7.09
6	8.24	8.34	7.90	8.20
7	8.11	8.06	8.53	6.67
8	8.23	8.45	8.47	7.02
9	7.46	8.10	8.38	8.21
10	8.05	7.65	8.18	8.47
11	7.95	8.28	8.19	8.39
12	7.90	8.09	8.26	8.31
13	7.70	8.37	8.44	7.53
14	7.93	8.20	7.53	8.12
15	8.10	7.98	7.54	7.19
16	7.97	8.09	7.11	7.49
17	8.04	8.40	8.47	6.90
18	7.98	8.35	8.18	8.49
19	8.08	7.90	8.39	7.63

Table 4: Seasonal changes in surface water nitrate concentrations at Sampling Stations

Stations	Nitrate Winter	Nitrate Spring	Nitrate Summer	Nitrate Autumn
1	2.70	4.43	4.87	1.60
2	5.50	6.20	5.00	2.70
3	5.50	1.40	2.60	0.50
4	5.50	3.50	3.10	0.70
5	5.10	4.20	3.40	2.30
6	7.50	4.43	5.80	3.70
7	8.40	5.50	6.00	6.20
8	5.90	6.20	6.20	6.10
9	6.00	5.80	4.10	2.80
10	8.90	6.60	3.54	2.70
11	7.00	6.20	4.00	3.30
12	6.20	5.80	4.78	2.80
13	6.20	6.60	3.60	5.40
14	7.00	5.50	4.43	4.60
15	5.50	5.50	1.90	4.39
16	8.86	6.20	2.00	4.20
17	8.40	6.60	3.00	5.44
18	6.60	6.60	2.90	7.04
19	2.20	10.00	8.50	1.90

Table 5: Seasonal changes in surface water phosphate concentrations at sampling stations

Stations	Phosphate winter	Phosphate spring	Phosphate summer	Phosphate autumn
1	Trace	0.001	0.10	0.02
2	0.02	0.001	0.065	0.07
3	Trace	0.02	0.101	0.01
4	0.07	0.06	0.122	0.03
5	0.06	0.06	0.18	0.03
6	0.10	0.06	0.36	0.04
7	0.26	0.07	0.11	0.12
8	0.07	0.05	0.101	0.14
9	Trace	0.05	0.49	0.04
10	0.001	0.06	0.76	0.07
11	Trace	0.001	0.05	0.05
12	Trace	0.001	0.20	0.03
13	0.025	0.001	0.052	0.19
14	0.124	0.03	0.084	0.13
15	0.06	0.06	0.074	0.18
16	0.124	0.05	0.70	0.11
17	0.11	0.125	0.146	0.21
18	0.125	0.125	0.75	0.25
19	0.225	0.275	0.532	0.48

Table 6: Seasonal distribution of phytoplankton in Jajerood river

Winter genus	Spring genus	Summer genus		Autum genus	
Navicula	*Navicula*	*Navicula*	*Stenopterobia*	*Cymbella*	*Ceratium*
		Caloneis	*Gyrosigma*	*Raphidiopsis*	*Oscillatoria*
Cocconeis	*Epithemia*	*Cocconeis*	*Fragilaria*	*Rhizosolenia*	
		Diatoma	*Cholorella*	*Diatoma*	
Cymbella	*Cymbella*	*Eunotia*	*Spyrogira*	*Fragilaria*	
		Frustularia	*Ceratium*	*Navicula*	
Diatoma	*Diatoma*	*Epithemia*	*Peridinium*	*Opephera*	
		Nitzchia	*Aphanocapsa*	*Surirella*	
Eunotia	*Eunotia*	*Amphipleura*	*Chorococcus*	*Cocconeis*	
		Melosira	*Anacystis*	*Asterionella*	
Frustulia	*Frustularia*	*Surirella*	*Oscillatoria*	*Nitzchia*	
		Cynedra	*Spirulina*	*Cyclotella*	
Melosira	*Rhapalodia*	*Oscillatoria*	*Phormidium*	*Stiuronesis*	
		Microcystis	*Lyngbya*	*Eunotia*	
Nitzchia	*Nitzchia*	*Gomphosphaeria*	*Microcystis*	*Gomphonneis*	
		Pinnularia		*Gyrosigma*	
Amphipleura	*Amphipleura*	*Rhapalodia*		*Ceratoneis*	
		Tabellaria		*Mastigloia*	
Asterionella	*Asterionella*	*Asterionella*		*Amphipleura*	
		Cyclotella		*Caloneis*	
Cyclotella	*Cynedra*	*Plagiotropis*		*Tabellaria*	
		Rhizosolenia		*Epithemia*	
Thalassionema	*Oscillatoria*	*Thalassionema*		*Hantzchia*	
		Amphora		*Cylandrotheca*	
Cholorella	*Microcystis*	*Raphidiopsis*		*Neidium*	
		Manguinea		*Cymatopleura*	
Spirulina	*Gomphosphaeria*	*Cymatopleura*		*Cynedra*	
		Plectonema		*Oocystis*	

Nutrients showed important seasonal cycles but no differences among seasons were statistically significant for these nutrients (nitrate+nitrite, phosphate). The lowest (0.5 μg L^{-1}) and highest (10 μg L^{-1}) nitrate+nitrite concentrations were found in autumn and spring respectively (Table 4). The lowest and the highest phosphate concentrations were trace in winter and 0.76 μg L^{-1} in summer. The changes in phosphate concentrations among the stations were not significant (Table 5).

Phytoplankton composition and abundance: A total of 53 taxa of phytoplankton were identified during the study. These taxa include 4 division that belonging to 39 genera of *Bacillariophyceae*, 9 genera of *Cyanophyceae*, 2 genera of *Dinophyceae* and 3 genera of *Chlorophyceae* (Table 6).

Diatoms were dominant in terms of the number of genus and their abundance. The highest number of genus was found in summer and only during this period was the number of the *Diatoms* genus higher than that of another phytoplanktons. The lowest phytoplankton genus number was determined in winter.

Cymbella, *Asterionella*, *Navicula*, *Diatoma, Nitzchia*, *Cocconeis*, *Synedra*, *Surirella*, *Epithemia were* the most dominant algae at all stations. *Chlorophyta* and *Dinophyta* were absent in spring.

The abundance of *Diatoms* was low in winter and spring (Table 6). The lowest phytoplankton genus number belongs to *Dinophyceae* (Table 6).

DISCUSSION

The 26 identified phytoplankton taxa in different parts of the Jajerood by Shadkam (2005). *Diatoms* and *Chlorophyceae* were dominant in terms of the number of genus and their abundance.

As this result shows, the cell number of *Diatoms* was the highest among the groups. The phytoplankton of rivers was dominated by *Diatoms,* whilst blue-green algae, green algae and Dinoflagellates were less significant (Cetin and Sen, 2004). The highest phytoplankton genus number was found in summer. The summer increase was attributed to the increase in the cell number of pennete *Diatoms*.

Centric *Diatoms* are one of the best adapted algal groups to turbulent and turbid systems (Izaguirre *et al.,* 2001), Whereas pinnate *Diatoms* are regarded as benthic forms. It has been reported that pinnate *Diatoms* were richer in number of taxa than centric forms in the phytoplankton of many shallow rivers (Cetin and Sen, 2004; Gonulol, 1985).

Phytoplankton cell numbers found in this study were higher than those previously reported by Shadkam (2005) for the Jajerood river. This could be due to the seasonal sampling programme of this study.

The seasonal variations of phytoplankton are related to a variety of environmental factors in aquatic environments (Wu and Chou, 1999). Water temperature and transparency are among the most important physical factors affecting the distribution and seasonal variations of phytoplankton in rivers (Harrison and Hildrew, 1998; Mosisch *et al*., 1999)

The increase in phytoplankton during the summer and Autumn months in river Jajerood could also be a result of the increasing water temperature.

The effects of water temperature on phytoplankton have been examined in many freshwater ecosystems and it was found that water temperature strongly regulates the seasonal variation of phytoplankton (Lund, 1965; Richardson *et al*., 2000; Izaguirre *et al*., 2001).

Light is a major resource for phytoplankton and has a complex pattern of spatial and temporal variability (Litchman, 2000). Suspended matter in river water increases in winter and spring, resulting in minimum transparency. During the summer the transparency was at its maximum level. There was also a significant correlation between the growth of phytoplankton and transparency in Jajerood river since the largest populations of all algae occurred during the summer whilst individual numbers were low in winter and spring.

No relation was observed between diatom growth and pH since high and low individual numbers were observed at similar pH levels in Jajerood (Table 3).

Nutrient concentrations in general decreased to their lowest level in autumn due to an increase in phytoplankton abundance. In general, significant negative relationships were found between phytoplankton abundance and nutrient concentration in this study. Exceptional increases in phytoplankton, as was the case in summer in this study, may be related to all the processes prevailing in the research area. Nutrient concentrations recorded in this research were lower than previous findings of Shadkam (2005) in Jajerood river.

Further study is necessary to understand the relationships between phytoplankton and environmental properties in the Jajerood river.

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