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A Study on the Algae in Fish Ponds and Their Seasonal Variations

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Abstract: In this study, the algae occurring in fish ponds of a fish production center were investigated with their seasonal variations for a period of a year. The algal flora of the ponds consisted of Bacillariophyta (64 taxa), Chlorophyta (14 taxa), Cyanophyta (9 taxa), Euglenophyta (6 taxa). The algae constituted pelagic and epilithic communities in the ponds. The diatoms were the most noticable algae in both communities and *Nitzschia* spp. were the most conspicuous algae followed by *Navicula* spp. and *Cymbella* spp. with respect to the frequency of occurrence and number of individuals in all ponds. The diatoms showed their best growths in winter and spring whilst they occurred in low numbers in the other seasons. Chlorophyta and Cyanophyta were other groups of algae in fish ponds occurring generally in summer and autumn.

Keywords: Algae, Seasonal Variations, Fish Ponds.

Balık Havuzlarındaki Algler ve Mevsimsel Değişimleri Üzerine Bir Çalışma

Özet: Bu çalışmada, Cip Balık Üretim Merkezi'ndeki balık havuzlarında ortaya çıkan algler ve mevsimsel değişimleri bir yıl süresince araştırılmıştır. Havuzların alg florası Bacillariophyta (64 taxa), Chlorophyta (14 taxa), Cyanophyta (9 taxa) ve Euglenophyta (6 taxa)'dan ibaret olmuştur. Havuzlarda pelajik ve epilitik kommuniteler oluşmuştur. Her iki kommunite içerisinde diyatomeler en çok kaydedilen algler olmuştur ve bütün havuzlarda ortaya çıkış sıklığı ve birey sayıları bakımından *Nitzschia* spp. üyeleri en göze çarpan algler olurken onları sırasıyla *Navicula* spp. ve *Cymbella* spp. üyeleri takip etmiştir. Diyatomeler, diğer mevsimlerde düşük sayılarda ortaya çıkarken en iyi gelişmelerini kış ve ilkbaharda gerçekleştirmiştir. Balık havuzlarındaki diğer alg grupları Chlorophyta ve Cyanophyta genellikle yaz ve sonbaharda ortaya çıkmıştır.

Anahtar Kelimeler: Algler, Mevsimsel Değişimler, Balık Havuzları.

1. Introduction

The algae which occur in fish production ponds is extremely important since they directly affect the properties of water quality such as colour, smell, taste, dissolved oxygen, turbidity [1]. Studies associated with algae in fish production ponds is concerned with various fields as live food, toxic algae and algal blooms. Algal blooms in commercial fish production ponds have extensively been studied and blue-green algae are reported to be most nuisance in fish ponds [2]. Some studies were concerned with fertilization and its effect on the algae in fish ponds [1] and others related to water quality control [3].

The purpose of the present study is to determine the species composition of algae and their seasonal variations in fish ponds of a fish production center. In addition, the productivity of fish ponds is also studied based on changes in chlorophyll *a* concentration.

2. Material and Method

The Cip Fish Production Center was built on a 17500 m^2 area near Cip Dam Lake (Elazig, Türkiye). There are two concrete ponds for rainbow trout (*Oncorhynchus mykiss*, Walbaum) and two soil ponds for carp (*Cyprinus carpio* L.) production. Ponds for Rainbow trout (16.5 m x 4.3 m x 1.10 m, in length, width and depth, respectively) were coded as P1, P2 and codes of P3 and P4 were assigned for carp ponds (30 m x 12.75 m x 1 m, in length, width and depth, respectively) for this study.

Algae and water samples were collected monthly intervals between September 1994 and August 1995. Algal samples were collected using a plankton net and Nansen Water Bottle for qualitative and quantitative examination. The epilithic algae were scrapped from the concrete walls and stones on the bottom of the soil ponds. The relative abundance method were applied for individual numbers of pelagic and epilithic algae and the results were expressed as "% organism"

[4] since it was hard to identify the live cells during counting process.

The water temperature, light transparency, pH of the pond's water were measured directly by means of a thermometer, a Secchii Disc, a pH meter and respectively. Organic matters were determined through titration analysis [5]. Spectrophotometric method was employed for the analysis of sulfate, silica, nitrate and ortho-phosphate and chlorophyll *a*[5].

3. Results

The monthly variations of physical and chemical characteristics of pond waters were given in Table 1.

As shown in Table1, the pond water is highly alkaline. During the research, pH values of the pond's water were generally ranged between 7.5 and 8.5. These values are suitable for both trout and carp production [1]. However, higher pH values (above 9.0) were also occasionally measured in carp ponds.

The amount of silica (SiO_2) in fish ponds was quite low never exceeding 0.3 mg/L. Minimum and maximum concentrations for orthophosphate and nitrate were 0.001-0.06 mg/L and 0.02-1.17 mg/L respectively. However sulfate concentration was higher than other dissolved substances in the ponds(Table 1).

Table 1. The monthly changes of physical and chemical properties of pond waters

Months	Ponds	Sechii depth **(cm)**	Temperature **(^oC)**	pH	Organic Matter **(mg/L)**	Silica **(mg/L)**	Sulfate **(mg/L)**	Nitrate **(mg/L)**	Ortho Phosphate **(mg/L)**
1994 Sept.	P1	20	21.0	7.8	4.2	0.10	24.3	0.18	0.011
	P2	23	20.5	7.9	2.7	0.08	24.7	0.20	0.020
	P3	29	23.5	8.3	2.3	0.08	23.4	0.07	0.007
	P4	31	23.5	8.3	3.0	0.13	24.4	0.07	0.007
Oct.	P1	23	15.0	8.1	5.4	0.11	37.1	0.00	0.003
	P2	23	15.0	8.0	5.4	0.11	32.1	0.00	0.004
	P3	48	16.0	8.4	5.4	0.05	35.1	0.91	0.003
	P4	48	16.0	8.5	5.4	0.09	29.4	0.14	0.003
Nov.	P1	30	11.0	8.1	5.0	0.11	43.5	0.29	0.007
	P2	28	11.0	8.1	4.5	0.10	42.0	0.14	0.009
	P3	51	11.5	8.3	3.5	0.08	37.4	0.08	0.010
	P4	56	11.5	8.3	4.0	0.07	36.5	0.08	0.009
Dec.	P1	45	3.5	8.3	3.9	0.08	42.6	0.57	0.007
	P2	42	3.5	8.4	3.9	0.06	43.2	0.66	0.003
	P3	76	3.3	8.5	3.7	0.06	42.0	0.45	0.004
	P4	76	3.3	8.6	4.5	0.08	43.0	0.49	0.006
1995 Jan.	P1	40	3.8	8.4	4.4	0.08	62.0	0.49	0.060
	P2	41	3.8	8.5	3.9	0.05	56.6	0.60	0.040
	P3	57	4.0	8.6	2.5	0.10	55.8	0.77	0.060
	P4	58	4.0	8.7	2.1	0.17	66.2	0.73	0.015
Feb.	P1	38	6.0	8.7	3.6	0.16	41.5	1.02	0.005
	P2	39	5.8	8.7	3.4	0.16	39.5	0.98	0.020
	P3	40	6.0	8.8	3.4	0.13	36.2	0.90	0.010
	P4	44	6.0	8.8	3.4	0.10	32.9	0.85	0.015
Mar.	P1	35	9.0	8.9	5.0	0.03	58.3	0.69	0.020
	P2	37	9.0	8.8	7.0	0.02	30.0	0.73	0.009
	P3	38	9.5	9.1	3.2	0.01	30.0	0.52	0.020
	P4	39	9.5	9.1	4.0	0.01	29.2	0.58	0.000
Apr.	P1	28	10.5	8.4	3.7	0.21	40.5	0.75	0.005
	P2	28	10.5	8.6	3.0	0.20	41.1	0.66	0.000
	P3	10	10.5	9.4	4.1	0.17	39.3	0.24	0.000
	P4	33	10.5	8.8	2.8	0.23	38.3	0.41	0.000
May	P1	41	14.5	7.7	1.8	0.12	26.0	0.53	0.015
	P2	43	16.0	7.6	1.8	0.08	27.6	0.44	0.015
	P3	27	30.0	9.4	6.7	0.13	20.8	0.05	0.000
	P4	36	17.0	8.0	1.4	0.11	24.8	0.28	0.000

Table 1. (Continued)

Months	Ponds	Sechii depth **(cm)**	Temperature **(°C)**	pH	Organic Matter **(mg/L)**	Silica **(mg/L)**	Sulfate **(mg/L)**	Nitrate **(mg/L)**	Ortho Phosphate **(mg/L)**
June	P1	64	14.0	7.5	1.6	0.10	21.6	0.17	0.000
	P2	64	14.0	7.5	0.6	0.06	26.6	0.08	0.000
	P3	56	17.0	9.4	7.8	0.10	18.9	0.06	0.000
	P4	70	18.5	8.4	0.8	0.09	29.0	0.10	0.000
July	P1	58	16.5	7.6	4.7	0.08	21.4	0.07	0.030
	P2	59	17.0	7.6	2.7	0.10	23.6	0.00	0.030
	P3	57	20.0	9.1	11.5	0.15	23.4	0.00	0.025
	P4	90	20.0	7.8	3.9	0.17	24.4	0.00	0.015
Aug.	P1	44	21.0	7.7	4.5	0.09	22.6	0.01	0.000
	P2	39	21.5	7.6	5.0	0.07	26.2	0.00	0.000
	P3	45	25.0	8.0	5.0	0.12	20.4	0.00	0.000
	P4	39	25.5	8.5	6.2	0.10	25.9	0.00	0.005

The algae occurred as pelagic and epilithic forms in the ponds, which were listed alphabetically in Table 2.

Table 2. Algae recorded in fish ponds

P1P: P1 Pelagic
P2P: P2 Pelagic
P2E: P2 Epilithic
P3P: P3 Pelagic
P3E: P3 Epilithic
P4P: P4 Pelagic

Taxon	**P1P**	**P2P**	**P2E**	**P3P**	**P3E**	**P4P**
BACILLARIOPHYTA						
Centrales						
Cyclotella comta (Ehr.)Kütz.	+	+	+	-	-	+
Cyclotella meneghiniana Kütz.	+	+	+	+	+	+
Cyclotella ocellata Pantocsek	+	+	+	+	+	+
Ellerbeckia arenaria (Moore) Crawford	+	+	+	-	-	-
Pennales						
Achnanthes minutissima Kütz	+	+	+	+	+	+
A. minutissima var. affinis (Grun.)Lange-Bertalot	+	+	-	-	+	-
Amphora libyca Ehrenberg	+	+	+	-	+	+
Caloneis silicula (Ehrenberg) Cleve	-	-	+	-	+	-
Cocconeis fluviatilis Wallace	+	-	+	+	-	+
Cocconeis pediculus Ehr.	+	+	+	+	+	+
Cocconeis placentula Ehr.	+	+	+	-	+	+
Cocconeis placentula v. *lineata* (Ehr.)Van Heurck	+	-	-	+	-	+
Cymatopleura elliptica (Brébisson)W.Smith	-	-	+	-	-	+
Cymatopleura solea (Brébisson)W.Smith	+	+	+	-	-	+
Cymbella affinis Kütz.	+	+	+	+	+	+
Cymbella cistula Ehrenberg Kirchner	+	-	+	+	-	+
Cymbella cymbiformis Agardh	-	+	+	+	-	+
Cymbella helvetica Kütz.	+	-	+	+	+	+
Cymbella microcephala Grun.	-	+	+	+	-	+
Cymbella obtusiuscula (Kütz.) Grun.	+	-	+	+	+	-
Cymbella parva (W.Smith.) Cl.	+	+	+	+	+	+
Cymbella prostrata (Berkeley)Cl.	+	+	+	-	+	+
Cymbella prostrata v.*auerswaldii* (R.)Reimer	+	+	+	-	+	+
Diatoma tenuis Agardh	+	+	+	+	+	+

Table 2. (Continued)

Diatoma vulgaris Bory	+	+	+	-	+	+
Fragilaria bicapitata A.Mayer	+	+	+	+	-	+
Fragilaria brevistriata Grunow in van Heurck	+	+	+	+	+	+
Fragilaria delicatissima (W.Smith) Lange-Bertalot	+	+	+	+	+	+
Fragilaria pinnata Ehr.	+	+	+	+	+	+
Fragilaria radians (Kütz.)Will & Round	+	+	+	+	+	+
Fragilaria ulna (Nitzsch) Lange-Bertalot	+	+	+	+	+	+
Gomphoneis olivaceum(Hornemann) Brébisson	+	-	+	-	-	-
Gomphonema angustum Kütz.	+	-	+	+	-	-
Gomphonema constrictum var.*capitata*(Ehr.)Cl.	+	+	+	-	+	+
Gomphonema olivaceum (Hornemann) Brébisson	+	+	+	+	-	+
Gomphonema parvulum (Kützing) Kützing	+	+	+	+	+	+
Gomphonema truncatum Ehr.	+	+	+	+	+	+
Gyrosigma acuminatum (Kützing) Rabenhorst	+	+	+	-	+	+
Hantzschia amphioxys (Ehr.) Grun.	-	-	+	+	-	-
Hantzschia spectabilis (Ehr.) Hustedt	-	-	+	+	-	+
Navicula capitatoradiata Germain	+	+	+	+	-	+
Navicula cryptocephala Kütz.	+	-	+	-	-	+
Navicula cryptotenella(Breb.) Lange-Bertalot	+	+	-	+	+	-
Navicula cuspidata (Kützing) Kützing	-	+	+	-	+	+
Navicula globulifera Hust.	-	-	+	-	-	+
Navicula gregaria Donkin	+	-	+	+	-	+
Navicula pupula Kütz.	-	-	+	-	-	+
Navicula radiosa Kütz.	+	-	+	-	+	-
Navicula rhynchocephala v.*amphiceros* Kütz.	+	+	-	-	+	+
Nitzschia acicularis (Kützing)W. Smith.	+	-	+	-	-	+
Nitzschia amphibia Grun.	+	+	+	+	+	+
Nitzschia constricta (Gregory) Grunow	+	+	+	+	+	+
Nitzschia dissipata (Kütz.) Grun.	+	+	+	+	+	+
Nitzschia hungarica Grun.	+	-	+	+	-	+
Nitzschia linearis (Agardh)W. Smith.	-	-	+	+	+	+
Nitzschia palea (Kütz.) W. Smith	+	+	+	+	-	+
Nitzschia recta Hantzsch	+	+	+	+	-	+
Nitzschia sigmoidea (Nitzsch) W. Smith	+	-	+	+	+	+
Nitzschia sinuata var. *tabellaria* (Grunow)Grunow	+	+	+	+	-	+
Nitzschia umbonata (Ehrenberg) Lange-Bertalot	+	+	+	+	+	+
Rhoicosphenia abbreviata (C.Agardh)Lange-Bertalot	+	-	+	-	+	-
Surirella angusta Kütz.	+	-	+	-	-	+
S. brebissonii v. *kuetzingii* Krammer&Lange-Bertalot	+	-	+	-	-	-
Synedra ulna var. *amphirhynchus* (Ehr.) Grun.	+	-	-	-	+	-
CHLOROPHYTA						
Chlorococcales						
Cerasterias staurastroides West&West	+	+	-	-	-	-
Chlamydomonas platyrhyncha Korshikov	-	+	-	+	-	-
Chlorella ellipsoidea Gerneck	-	+	-	-	+	+
Coelastrum microporum Nägeli in A.Braun	+	-	+	+	-	-
Coelastrum reticulatum (P.A.Dangeard) Senn	+	+	-	+	-	+
Dictyosphaerium pulchellum H.C.Wood	-	+	-	-	+	+
Monoraphidium irregulare (G.M.Smith) K-L	+	+	-	+	-	+
Ourococus bicaudatus Grob.G.M.Smith	+	+	-	-	+	-
Scenedesmus bijuga (Turpin) Lagerheim	+	+	-	+	-	+
Scenedesmus dimorphus (Turpin) Kützing	+	+	-	+	-	+
Scenedesmus quadricauda(Turpin) de Brébisson	+	-	+	+	-	+
Westella linearis G.M.Smith.	+	+	-	-	+	-
Desmidiales						
Cosmarium botrytis Meneghini ex Ralfs	-	+	-	+	-	+
Zygnematales						
Spirogyra porticalis (Muell.) Cleve	-	-	-	+	-	+

Table 2. (Continued)

CYANOPHYTA						
Chroococcales						
Merismopedia elegans A.Braun in Kützing	-	+	-	+	-	+
Microcystis aeruginosa (Kütz) Kütz.	+	+	-	-	+	-
Hormogonales						
Oscillatoria amphibia [C.A.Agardh 1827]Gomont	+	-	+	+	-	+
Oscillatoria beggiatoiformis(Grun.)Gom.	+	-	+	-	+	+
Oscillatoria brevis [Kützing]Gomont	-	+	+	-	-	+
Oscillatoria simplicissima Gomont	+	-	+	-	+	+
Oscillatoria tenuis [C.Agardh]Gomont	+	-	-	-	-	+
Phormidium anomala Rao.	+	+	-	+	-	-
Spirulina princeps (West & West) G.S.West	+	+	-	-	+	+
EUGLENOPHYTA						
Euglenales						
Euglena acus Ehrenberg	-	+	+	-	-	+
Euglena gracilis G.A.Klebs	+	-	+	-	+	-
Euglena proxima P.A.Dangeard	+	-	-	+	-	+
Phacus chloroplastes Prescott	+	+	+	-	-	-
Phacus Nordstedtii Lemmermann	+	+	-	-	+	+
Phacus orbicularis K.Hübner	+	-	+	-	+	-

Changes of relative abundance (%) of conspicuous diatoms in pelagic and epilithic communities in each fish pond were given in separate tables (Tables 3–8).

Of all, *Cyclotella meneghiniana* and *C. ocellata* were the most important pelagic algae in the P1 pond with respect to frequency of occurrence and relative abundance (Table 3). These diatoms existed in the pond water throughout the year except June. Although *Gomphonema constrictum* var. *capitata* occurred on less occasions, its abundance in july (41 %) was noticable.

Table 3. The monthly changes in relative abundance (%) of conspicuous diatoms in pelagic community of the pond P1

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Cyclotella meneghiniana	21	26	19	27	36	2	9	67	12	-	14	2
Cyclotella ocellata	41	40	36	26	23	11	10	28	7	-	12	19
Achnanthes minutissima	-	4	12	21	38	29	2	2	5	3	2	-
Gomphonema cons. var. *capitata*	-	-	-	13	2	10	9	-	1	-	41	-
Nitzschia acicularis	14	8	31	24	14	-	2	1	-	2	-	-

In the pond P2, *Cyclotella meneghiniana*, *C. ocellata, Achnanthes minutissima* and *Nitzschia acicularis* were the most conspicuous algae in the pelagic community (Table 4) as they were in the pond P1). In this pond, *Gomphonema truncatum* was significant with its high relative abundance (60 %) in February. This diatom was recorded more frequently in spring than other seasons.

Table 4. The monthly changes in relative abundance (%) of conspicuous pelagic diatom taxa in the pond P2

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Cyclotella meneghiniana	33	4	36	12	10	-	10	74	13	20	4	36
Cyclotella ocellata	13	6	22	19	15	-	8	3	33	-	22	-
Achnanthes minutissima	14	4	8	38	-	14	8	7	14	-	4	-
Gomphonema truncatum	-	12	-	2	-	60	1	3	8	20	-	3
Nitzschia acicularis	30	-	6	4	15	-	-	-	-	-	4	-

The diatoms were recorded as the most important algae in the epilithic community of the pond P2 (Table 5) and *Achnanthes minutissima* was the most conspicuous with its high relative abundance, particularly in the autumn and spring. The occurrence of *Cymbella affinis* with 56 % relative abundance in June was noticable. Although *Cyclotella* spp., were conspicuous in pelagic community, they were not abundant in the epilithic flora; their relative abundance never exceeded 20 %.

Table 5. The monthly changes in relative abundance (%) of conspicuous epilithic diatom taxa in the pond P2

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Cyclotella ocellata	-	13	2	20	-	-	-	8	18	-	4	17
Achnanthes minutissima	21	33	33	21	11	20	-	33	22	-	3	3
Cymbella affinis	-	2	-	5	1	18	-	4	4	56	7	6
Gomphonema truncatum	4	2	2	-	2	12	2	2	12	2	-	8
Navicula capitatoradiata	-	-	4	11	4	3	4	6	4	4	1	3

Differing from other ponds, *Fragilaria bicapitata* was more significant in the pelagic community in pond P3 in terms of the frequency of occurence and relative abundance (Table 6). This diatom was recorded in high cell numbers almost in all seasons. However, the relative abundance of the diatom was higher in the summer months than the other seasons. *Cyclotella meneghiniana*, *C. ocellata* and *Achnanthes minutissima* were other noticable pelagic algae in the pond P3 as they were recorded in the ponds of P1 and P2. *Cyclotella meneghiniana* and *C. ocellata* grew better in the pelagic community in the period of September-December whilst *Achnanthes minutissima* was significant in the period of December-March.

Table 6. The monthly changes in relative abundance (%) of conspicuous pelagic diatom taxa in the pond P3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Cyclotella meneghiniana	10	20	20	16	1	2	2	-	1	-	2	-
Cyclotellata ocellata	25	24	23	40	8	-	4	1	1	-	3	-
Achnanthes minutissima	-	-	9	38	14	27	28	8	6	-	-	-
Fragilaria bicapitata	-	51	8	-	32	11	13	22	25	61	55	39
Fragilaria radians	-	-	-	-	15	20	7	35	2	-	4	2

Among the epilithic algae of the pond P3, *Achnanthes minutissima*, *Cymbella affinis, Fragilaria pinnata and Nitzschia sinuata* var. *tabellaria* were significant with their high relative abundance in October, in april, in July and in may respectively (Table 7). These diatoms grew better during spring and summer.

Table 7. The monthly changes of relative abundance (%) of conspicuous epilithic diatom taxa in the pond P3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Achnanthes minutissima	28	36	13	11	11	14	15	1	1	-	-	8
Cymbella affinis	5	-	4	4	-	6	-	34	9	19	2	-
Fragilaria bicapitata	-	12	3	-	-	13	3	11	5	26	35	12
Fragilaria pinnata	12	-	6	16	-	6	4	20	14	19	55	-
Nitzschia sinuata v. tabellaria	-	7	4	-	-	5	11	8	35	1	2	8

Cyclotella meneghiniana and *C. ocellata* were recorded as the most important pelagic algae in the pond P4 with respect to frequency of occurrence and relative abundance (Table 8). *Fragilaria delicatissima* and *F. ulna* were also significant with their high relative abundance in the spring months.

Table 8. The monthly changes of relative abundance (%) of conspicuous pelagic diatom taxa in the pond P4

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Cyclotella meneghiniana	47	18	21	27	5	-	-	12	45	-	6	25
Cyclotella ocellata	11	9	28	28	5	-	14	11	-	-	11	-
Achnanthes minutissima	1	3	4	-	5	-	14	12	-	14	-	-
Fragilaria delicatissima	-	-	-	-	-	-	-	-	28	4	8	-
Fragilaria ulna	-	12	6	-	-	-	14	27	-	-	-	-

4. Discussion

This study revealed the existence of pelagic and epilithic algal communities in the fish ponds studied. Both communities constituted by algae belonging to Bacillariophyta, Chlorophyta, Cyanophyta and Euglenophyta. A total of 93 taxa were recorded and Bacillariophyta was the richest in species composition with 64 taxa. Bacillariophyta was followed by Chlorophyta (14 taxa), Cyanophyta (9 taxa), Euglenophyta (6 taxa). A previous study conducted in the concrete ponds [6] also showed the species richness of diatoms among other algae.

Of all the algae, *Nitzschia* (11 taxa), *Navicula* (9 taxa) and *Cymbella* (9 taxa) were the richest in species number in both pelagic and epilithic communities. However *Nitzschia, Navicula* and *Cymbella* have been recorded as the genera represented with most numerous species in many studies carried out in the same region [7-11]. These findings may show that the species belonging to *Nitzschia, Navicula* and *Cymbella* are more cosmopolitan than other diatoms in terms of expansion. *Ellerbeckia, Amphora, Caloneis, Gomphoneis, Gyrosigma, Rhoicosphenia* and *Synedra* were noticable being represented with only one species during the study.

During the study, *Cyclotella ocellata* and *Fragilaria ulna* were more significant than other diatoms and algae since they were recorded in both epilithic and pelagic communities with larger populations. A similar finding for these algae was also previously reported [6]. These findings may indicate that, these diatoms have a larger ecological tolerance against the possible changes of conditions in the ponds across the year. This may be particularly true for *Cyclotella ocellata* and *Fragilaria ulna*, which appeared with high cell numbers in two different studies performed in the same fish ponds at a six year interval.

In the ponds, diatoms were the dominant algae and they had their best growth in spring and fall, while winter and summer periods mostly coincided with lower cell numbers. Water temperature and light have been reported as the most effective factors on seasonal developments of algae; however, other factors also affected the growth of algae [12]. The relation between the water temperature of the fish ponds and algal growth in the present supported this generalization since the increasing water

temperatures supported the growth of diatoms. It has been stated that the amount of silica decreases while diatoms increase [12]. This study, supported this finding since the decrease in silica concentration usually coincided with the growth period of the diatoms.

Chlorophyta and Cyanophyta were other important algal groups in the ponds. Although green algae have been recorded in samples in every season, they were richer in species composition in summer and winter when diatoms were represented with less species. *Scenedesmus* (3 taxa) and *Coelastrum* (2 taxa) were the richest genera in terms of species number. Although *Dictyosphaerium* and *Chlorella* were represented with only one species, they were present in the ponds almost throughout the study. *Cosmarium* appeared in the ponds only in summer months.

Euglena has been the most important genus in Euglenophyta as being represented with 9 taxa. The existence of Euglenophyta in water is a proof for the richness of water with organic substances [13]. This finding was supported with the present study since *Euglena* species showed better growth in summer and autumn when the concentration of organic matter in the pond water was higher in the ponds.

Oscillatoria was the richest blue-green algal genus in species composition. The occurrence of the blue-green algae, especially *Microcystis aeruginosa,* in summer and autumn was noticable, thus supporting the Round [14] view's that the blue-green algae *Microcystis, Anabaena, Aphanizomenon, Lyngbya* and *Oscillatoria* grow better and are more common especially in summer months.

Blue-green algae play an important role not only with their property of growing very fast but also with their effects on aquatic environment and on other organisms in fish ponds. It has been recorded in many studies that blue-green algae give out various metabolic substances in water [15-17]. Some of blue-green algae have the property of secreting toxin; *Anacystis (Microcystis), Anabaena, Aphanizomenon, Coelosphaerium, Gloeotrichia, Nodularia, Oscillatoria* and *Rivularia* are the known toxic blue-green algae [18]. Some of these algae (such as *Microcystis, Coelosphaerium*) cause the death of zooplankters such as *Daphnia, Cyclops*, *Eudiaptomus* [19-21]; whereas other toxic blue-green algae have harmful effects on fish. Lefevre et al., [22] have reported that carp and crane fish died because of the toxin secreting property of these algae in the Moraccan Lake, where all four species of *Microcystis* grow well. According to Gorham [23], the most harmful one among all toxic blue-green algae was *Microcystis aeruginosa*. All the fish died right after the period when *Microcystis aeruginosa* increased in an extreme level in one of the fish ponds establishment in France. However in the present study *Microcystis aeruginosa* appeared only in trout ponds with low cell numbers. However, there has not been any change in the water quality of the pond, such as an increase in concentration of ammonia, after the growth period of *M. aeruginosa.* This finding may show that *M. aeruginosa* cannot be regarded as nuisance alga in the studied fish ponds for the time being. However growth of this alga should be monitored regularly in the ponds.

The average chlorophyll *a* concentration in ponds was 5 µg/L indicating the low algal growth. However low chlorophyll *a* concentrations were reported for unfertilized fish ponds [24-26]. This may be accepted as a desirable condition for rainbow trout production since this can give rise to least turbidity in the ponds. However, chlorophyll *a* concentration are needed to be increased for carp production through fertilization.

It may be worth to mention that the diatom, *Ellerbeckia arenaria* was recorded for the first time with this study in the freshwater ecosystems within the Province of Elazig. *E. arenaria* was recorded both as epilithic and pelagic form only in August.

5. References

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