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Research Article

A Study on the Epiphytic Algae of the Nilüfer Stream (Bursa)

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Abstract: In our study, water samples were taken monthly between August 1997 and June 1998 from six selected stations in the region, from the source of the Nilüfer stream to the point where it joins the Marmara Sea. Temperature (C°), pH, total dissolved substance (TDS), conductivity (EC), dissolved oxygen (DO) and biochemical oxygen demand (BOD5) values of the samples were measured.

The epiphytic algal flora, and the population density and the abundance degree of species were determined. In the community of epiphytic algae, members of *Bacillariophyta* were dominant and *Encyonema minutum* (Hilse ex Rabh.) D.G.Mann, (*Cymbellaceae*), *Achnanthidium minutissimum* (Kütz.) Czarn. (*Achnanthaceae*), *Navicula cryptocephala* Kütz. var. *cryptocephala* (*Naviculaceae*), *N. cryptocephala* var. *veneta* (Kütz.) Rabh. (*Naviculaceae*), *Nitzschia palea* (Kütz.) W.Smith (*Nitzschiaceae*), and *Synedra ulna* (Nitz.) Ehr. var. *ulna* (*Fragilariaceae*) were the most frequent species found. In addition to diatoms, the members of *Chlorophyta*, *Cyanophyta*, *Chrysophyta*, *Cryptophyta* and *Euglenophyta* were represented by a few species.

Key Words: Epiphytic Algae, Stream

Nilüfer Çayı (Bursa) Epifitik Algleri Üzerinde Bir Araştırma

Özet: Çalışmamızda Nilüfer çayını besleyen membadan başlayarak Marmara Denizi'ne döküldüğü bölge üzerinden seçilen 6 istasyondan Ağustos 1997-Haziran 1998 tarihleri arasında her ay periyodik olarak su örneği alınmıştır. Alınan örneklerde sıcaklık (C°), pH, total çözünmüş madde (TDS), iletkenlik (EC), çözünmüş oksijen (DO) ve Biyokimyasal Oksijen İhtiyacı (BOD5) ölçülmüştür.

Epifitik alglerin florası, populasyon yoğunlukları ve türlerin bolluk dereceleri saptanmıştır. Epifitik alg topluluklarında *Bacillariophyta* grubuna ait türler dominant olmuş ve *Encyonema minutum* (Hilse ex Rabh.) D.G.Mann, (*Cymbellaceae*), *Achnanthidium minutissimum* (Kütz.) Czarn (*Achnanthaceae*), *Navicula cryptocephala* Kütz. var. *cryptocephala* (*Naviculaceae*), *N. cryptocephala* var. *veneta* (Kütz.) Rabh (*Naviculaceae*), *Nitzschia palea* (Kütz.) W.Smith (*Nitzschiaceae*), *Synedra ulna* (Nitz.) Ehr. var. *ulna* (*Fragilariaceae*) türleri diğer diyatome türlerine göre daha sık bulunmuşlardır. Diyatomeler dışında *Chlorophyta*, *Cyanophyta*, *Chrysophyta*, *Cryptophyta* ve *Euglenophyta* üyeleri birkaç tür ile temsil edilmişlerdir.

Anahtar Sözcükler: Epifitik Alg, Akarsu

Introduction

In recent years, in addition investigations on lakes and lagoons, algological studies related to streams have been carried out. Epipelic, epiphytic and epilithic algal flora and the effects of pollution on them were determined in the Meram stream (Yıldız, 1984a, 1984b, 1985), Altınapa dam lake (Yıldız, 1987a), Porsuk river (Yıldız, 1987b), Kızılırmak (Yıldız, 1991), Aras river (Altuner, 1988), Karasu river (Altuner and Gürbüz, 1991), Samsun-İncesu river (Gönülol and Arslan, 1992) and Kızılırmak "Sivas inlet and outlet" (Dere (Ünal) and Sıvacı, 1995).

In previous research done on the Nilüfer stream, the emphasis was on the chemical and bacteriological aspects of the water of the stream and its branches. However, changes in the other living organisms were not investigated (Yılmaz et al., 1998; Anonymous, 1976, 1993)

Environmental pollution has reached its peak in Bursa for the time being. Bursa is an industrial city, and water pollution has become the most important problem for the people. The Nilüfer stream is polluted by domestic and industrial wastes at certain points on its route of 168 km from its source to the point where it flows into the sea.

The epiphytic algae act as indicators of the extent of water pollution, as well as being of great importance as primary producers in the food chain in water ecosystems.

Therefore, in this study, we aimed to determine the pollution level of the stream through an investigation of the epiphytic algal flora and thus make a contribution to the largely unknown algal flora.

The Study Area

The Nilüfer stream is about 10 km north-east of the centre of Keles and the south-east slopes of Tepel mountain and it flows north-west across the valley. The Nilüfer stream basin measures 168 km in length and 3-4 km in width. The stream basin covers 41130 ha. Its altitude is 666. Palaeozoic formations that surround the southeast and the northeast of the plain form the oldest reef of the region. These formations consist of marble.

The samples were taken from 6 stations selected on the 168 km route of the Nilüfer stream from its source to the point where it joins the sea (Figure 1).

Baraklı station is located at 29º 13' 50" E, 39º 57' 53" N in Kütahya; Doğancı Dam Station is located at 29º 00' 06" E, 40º 04' 58" N in Bursa; Abdal Bridge station is located at 29º 00' 50" E, 40º 13' 03" N in Bursa; Dereçavuş station is located at 29º 00' 27" E, 40º 17' 15" N in Bursa; Göbelye is located at 28º 46' 44" E, 40º 15' 51" N in Bursa; Hayırlar station is located at 28º 27' 35" E, 40º 17' 47" N in Bursa. All stations are in the Marmara Sea region of Turkey.

Baraklı, the first station, is near the source of the river on the south-western slopes of mount Tepel (2012 m), 10 km north-west of Keles county centre located, on the southern slopes of Uludağ mountain. The water at this station has the quality of spring water and does not contain wastes. The material on the banks of the stream is fine sand; however, pebbles are occasionally found.

The second station was at Doğancı Dam, which was built with the aim of supplying Bursa with water until the year 2005. This was different from the first station in the way that it was affected by nature and pollutants from small residences. The material on the banks of the stream is similar to that at the first station.

The third station, nearly 15 km from Doğancı Dam, is at Abdal bridge. This is where the Nilüfer stream starts to be polluted by water from sewers. The ground at this station is covered by large stones.

The fourth station was in the Dereçavuş region, where industrial and domestic wastes start to mix with each other at rates of 60% and 40%, respectively. In this region, the water level was higher compared with the other stations and difficulties were encountered in sampling since the banks of the river were completely covered with water.

After the fourth station, Ayvalı creek, which carries waste water from the organised industrial estate of Bursa, flows into the Nilüfer stream. The region where 80% industrial waste is mixed with 20% domestic waste is the location for the fifth station, Çekrice (Göbelye). The base of this station is covered with fine sand.

The Nilüfer stream flows in a wide valley and joins the Simav stream, which flows into the Marmara Sea south of Dock Cove. In Hayırlar, the sixth station in this region,

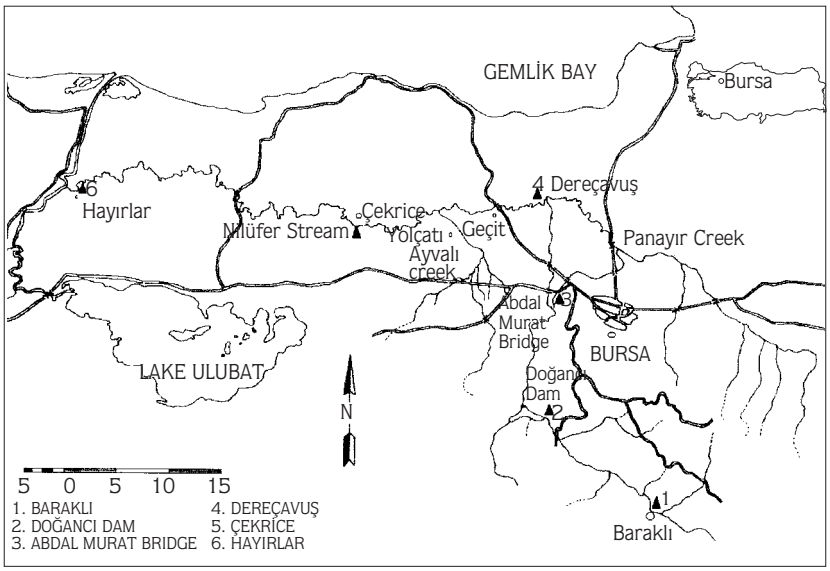

Figure 1. Sampling Stations on the Nilüfer Stream.

it was observed that in the summer months the flow rate of the water slowed down and the level of the water fell, which led to cracks in the soil on the sides of the river. At this station, the ground is covered with dark-coloured sediments.

Materials and Methods

Sampling, Enumeration and Identification

Epiphytic samples were taken regularly from each station, except from the third and fifth stations in August 1997 due to both the increase in water capacity and the unsuitable ground structure. Epiphytic samples were collected from the leaves of *Phragmites* spp., which were widespread in the water. The methods of collection and laboratory examination were those previously described by Round (1953) and Sladeckova (1962). The species were determined based on the 'Relative Frequency' by Braun-Blanquet (Williams, 1987). Taxonomic identifications were carried out under a Prior light microscope (Bourelly, 1966, 1968, 1970; Hustedt, 1930; Patrick and Reimer, 1966, 1975; Prescott, 1973; Round et al., 1990).

Physical and Chemical Parameters

The samples were taken periodically once a month from 6 stations between August 1997 and June 1998. Temperature (C°), pH, dissolved oxygen (DO), biochemical oxygen demand (BOD_5), total dissolved substance (TDS) and conductivity (EC) were measured.

Dissolved Oxygen (DO): The Winkler (idiometric) method (Şengül and Türkman 1985) was used to determine the values of dissolved oxygen. The dissolved oxygen values were calculated immediately, at the sampling site.

Biochemical Oxygen Demand (BOD_5): The samples were brought to the laboratory in order to determine the biochemical oxygen demand and the value of the dissolved oxygen on the first day was calculated by subtracting from the value of dissolved oxygen on the fifth day after holding at 20ºC, and then dividing by the dilution rate after the necessary dilutions were made following the preparation of diluted water (Şengül and Türkman, 1985).

The Measurement of Temperature (C°), pH, Total Soluble Substance (TDS) and Conductivity (EC) Values: temperature, total soluble substance and conductivity values were measured by a field-type WTW LF95 brand apparatus, and the pH by a CE brand apparatus.

Results

Physical and Chemical Characteristics of Stations

The results of some physical and chemical parameters measured in the Nilüfer stream are given in Tables 1-6. The physical and chemical features of the Nilüfer stream varied between seasons and stations. In monthly measurements, there were some variations in temperature from 7ºC to 31.5ºC, in dissolved oxygen level from 0 to 14.2 mg/lt, in pH from 6.9 to 8.8 and in electrical conductivity from 144 to 1772 mµohm/cm.

The Flora of Epiphytic Algae and Their Composition

A total of 173 species belonging to the divisions *Bacillariophyta*, *Chlorophyta*, *Chrysophyta*, *Euglenophyta*, *Cryptophyta* and *Cyanophyta* were determined in the investigations performed in the Nilüfer stream between August 1997 and June 1998. The list of available species is given in Table 7, according to Round's (Round, 1973, 1981; Round et al., 1990) classification.

The abundance of epiphytic algae varied among the stations. On all the sampling dates, except October 1997, most of the total organisms consisted of the

Table 1. Some physical and chemical characteristics of the first station (Baraklı).

Parameters	A	S	O	N	D	J	F	M	A	M	J	Mean±SD
Temperature (°C)	15.3	11.6	4.1	7.1	3.9	0.7	3.8	2.6	10.3	14.4	20.1	9.3±1.87
DO (mg/l)	8.4	8.8	11.2	10.4	11.5	12.4	11.2	8.4	9.5	8.3	7.25	9.7±0.45
BOD_5 (mg/l)	14	10	13	12	14	18	15	28	32	36	39	20±3.06
pH	7.8	7.4	7.6	8.1	7.1	7.5	6.9	7.8	7.9	7.4	7.1	7.5±0.11
EC (25°C)(mµohm/cm)	155	157	144	178	257	278	195	227	160	170	205	192±12.2
TDS (mg/l)	122	123	113	134	222	240	169	170	120	142	171	155.5±11.7

Table 2. Some physical and chemical characteristics of the second station (Dam inlet).

Parameters	A	S	O	N	D	J	F	M	A	M	J	Mean±SD
Temperature (°C)	15.3	13.9	7.9	10.1	6.5	2.3	6.4	4.5	11.1	15.9	24.3	11.7±1.99
DO (mg/l)	8.4	10.5	11	10.5	11.5	12.5	11.4	8.4	10.2	8.8	9.1	10.08±0.39
BOD_5 (mg/l)	30	22	27	23	32	27	33	42	54	47	58	35±3.54
pH	7.8	8	7.9	8.5	7.4	7.7	7.4	8	8.1	7.7	7.8	7.9±0.11
EC (25°C)(mµohm/cm)	155	447	375	350	386	381	360	362	322	338	411	361±21.86
TDS (mg/l)	122	350	295	264	333	330	311	273	243	282	393	295±20

Table 3. Some physical and chemical characteristics of the third station (Abdal Murat Bridge).

Parameters	A	S	O	N	D	J	F	M	A	M	J	Mean±SD
Temperature (°C)	19	16.3	10.4	11.3	7.6	3.3	7.4	5.8	14	17.8	30.5	14.5±2.6
DO (mg/l)	10.8	4.5	11	10.2	14.2	10.5	9.6	12.2	8.9	8.8	7.4	9.6±0.7
BOD_5 (mg/l)	80	65	80	75	82	75	82	75	78	82	84	79±1.78
pH	8.4	7.7	7.9	8.4	7.6	7.5	7.6	8.2	8.2	7.7	8.1	8±0.11
EC (25°C)(mµohm/cm)	410	516	375	427	378	473	369	375	364	326	404	419±23.1
TDS (mg/l)	312	404	295	322	327	409	319	282	274	272	336	336±18.3

Table 4. Some physical and chemical characteristics of the fourth station (Dereçavuş).

Parameters	A	S	O	N	D	J	F	M	A	M	J	Mean±SD
Temperature (°C)	20.4	15.3	14.5	13.1	9.5	8.7	8.8	7.7	11.5	16	25.3	14.6±1.75
DO (mg/l)	0	0	0	0	2.9	0	7.5	0	4.6	4	0	1.58±0.73
BOD_5 (mg/l)	185	140	130	120	120	130	124	145	134	125	185	142.7±7.1
pH	8	7.5	7.3	8.1	7.2	7.6	7.4	7.8	7.9	7.5	7.3	7.6±0.09
EC (25°C)(mµohm/cm)	977	1576	1343	1006	820	1049	667	619	703	578	1220	995±95.4
TDS (mg/l)	767	1236	1148	759	710	908	577	466	530	482	1019	807±77.7

Table 5. Some physical and chemical characteristics of the fifth station (Göbelye).

Parameters	A	S	O	N	D	J	F	M	A	M	J	Mean±SD
Temperature (°C)	20	15.1	14.7	13.6	10	7.9	10.8	8.5	12.1	17.9	25	14.9±1.65
DO (mg/l)	0	0	0	0	0.5	1.5	3.3	0	0.35	0.5	0	0.5±0.28
BOD_5 (mg/l)	165	150	160	110	160	130	115	155	162	104	164	144±6.59
pH	8	7.5	7.8	8.2	7.1	7.3	7.2	7.6	7.7	7.3	7.1	7.5±0.11
EC (25°C)(mµohm/cm)	1012	1772	1219	1362	927	966	764	705	856	655	1390	1088±99.6
TDS (mg/l)	795	1389	987	1027	802	835	661	531	645	547	1160	875±76.9

Table 6. Some physical and chemical characteristics of the sixth station (Hayırlar).

Parameters	A	S	O	N	D	J	F	M	A	M	J	Mean±SD
Temperature (°C)	22.1	15.6	15.1	12.4	9	7.7	11.3	9.7	12.3	19.7	25.7	15.4±1.8
DO (mg/l)	0	0	0	4.9	5.5	6.7	4.7	0	4	3.6	0	2.45±0.7
BOD_5 (mg/l)	240	200	220	180	200	210	205	210	217	195	262	215.7±6.9
pH	7.9	7.3	7.4	7.7	7.1	7.3	7.1	7.6	7.4	7.3	7.1	7.4±0.09
EC (25°C)(mµohm/cm)	1415	1964	1644	903	896	906	746	797	761	652	1380	1147.8±129.5
TDS (mg/l)	1110	1535	1217	680	775	784	645	600	573	544	1151	912±98.03

Table 7. The epiphytic species determined in the Nilüfer stream.

DIVISION: BACILLARIOPHYTA
CLASS: DIATOMATAE
ORDER: CENTRALES
Aulacoseira granulata (Ehr.) Simonsen
Aulacoseira granulata var. *angustissima* (O.Müll.) Simonsen
Aulacoseira italica subsp. *subarctica* (O.Müll.) Simonsen
Cyclotella glomerata Bachmann
Cyclotella meneghiniana Kütz.
Cyclotella ocellata Pant.
Melosira varians C.A.Agardh
Stephanodiscus niagarae Ehr.

ORDER: PENNALES
Achnantidium exiguum var. *heterovalvum* (Krasske) Czarn
Achnantidium lanceolatum Breb. in Kütz.
Achnantidium lanceolatum var. elliptica Cleve
Achnantidium minutissimum (Kütz.) Czarn.
Amphora ovalis (Kütz.) Kütz. var. *ovalis*
Amphora perpusilla (Grun.) Grun. var. *perpusilla*
Amphora veneta Kütz. var. *veneta*
Asterionella formosa Hass. var. *formosa*
Caloneis bacillum (Grun.) Cl. var. *bacillum*
Caloneis ventricosa var. *truncatula* (Grun.) Meist.
Cocconeis pediculus Ehr. var. *pediculus*
Cocconeis placentula Ehr. var. *placentula*
Cocconeis placentula var. *euglypta* (Ehr.) Cl.
Cocconeis placentula var. *lineata* (Ehr.) V.H.
Cocconeis scutellum Ehr.
Craticula cuspidata (Kütz.) D.G.Mann.,
Cymatopleura solea (Breb.) W.Smith
Cymatopleura elliptica (Breb.) W.Smith
Cymbella affinis Kütz. var. *affinis*
Cymbella cistula (Ehr.) Kirchn. var. *cistula*
Cymbella cymbiformis Ag. var. *cymbiformis*
Cymbella lanceolata (Ag.) Ag. var. *lanceolata*
Cymbella microcephala var. *crassa* Reim.
Diatoma ehrenbergii Kütz.
Diatoma hiemale var. *mesodon* (Ehr.) Grun.
Diatoma vulgare Bory. var. *vulgare*
Diploneis elliptica (Kütz.) Cl. var. *elliptica*
Encyonema minitum (Hilse) D.G.Mann
Encyonema silesiacum (Bleisch) D.G.Mann
Enyconema prostratum (Berkeley) Kützing
Enyconema auerswaldii Rabenh.
Epithemia adnata (Kütz.) Breb. var. *adnata*
Eunotia praerupta Ehrenberg
Fallacia pygmaea (Kütz.) A.J.Stickle & D.G.Mann
Fragilaria crotonensis Kitton var. *crotonensis*
Fragilaria intermedia Grun.
Fragilaria sp.
Fragilaria vaucheriae (Kütz.) Peters. var. *vaucheriae*
Geissleria schönfeldii (Hust.) Lange-Bert. & Metzeltin
Gomphoneis olivacea (Lyngbye) Dawson
Gomphoneis olivacea var. *calcarea* (Cleve) Poulin
Gomphonema abbreviatum Ag. var. *abbreviatum*
Gomphonema acuminatum Ehr. var. acuminatum
Gomphonema angustatum (Kütz.) Rabh. var. angustatum
Gomphonema olivaceum var. *minutissima* Hust.
Gomphonema parvulum var. *micropus* (Kütz.) Cleve
Gomphonema parvulum (Kütz.) var. *parvulum*
Gyrosigma acuminatum (Kütz.) Rabh. var. *acuminatum*
Gyrosigma exile (Grun.) Reim. var. exile
Hannaea arcus (Ehr.) Patr. var. arcus
Hannaea arcus var. amphioxys (Rabh.) Patr.
Hantzschia amphioxys (Ehr.) Grun.
Meridion circulare (Grev.) Ag. var. *circulare*
Navicula arvensis Hust. var. *arvensis*
Navicula capitata Ehr. var. *capitata*
Navicula contempta Krasske
Navicula cryptocephala Kütz. var. *cryptocephala*
Navicula cryptocephala var. *intermedia* Grun.
Navicula cryptocephala var. *veneta* (Kütz.) Rabh.
Navicula exiqua var. *capitata* Patr.
Navicula gregaria Donk. var. *gregaria*
Navicula lanceolata (Ag.) Kütz. var. *lanceolata*
Navicula meniscullus Schum.
Navicula mutica var. *binodis* Hust.
Navicula radiosa Kütz. var. *radiosa*
Navicula cryptotenella Lange-Bert.
Navicula tripunctata (O.F.Müll.) Bory var. *tripunctata*
Navicula viridula (Kütz.) Kütz. emend. V.H., var. *viridula*
Neidium affine (Ehr.) Pfitz. var. *affine*
Neidium binode (Ehr.) Hust. var. *binode*
Nitzschia acicularis W.Smith
Nitzschia amphibia Grun.
Nitzschia dissipata (Kütz.) Grun.
Nitzschia filiformis (W.Smith) Hust.
Nitzschia frustulum var. *perpusilla* Rabh.
Nitzschia gracilis Hantzsch
Nitzschia holsatica Hust.
Nitzschia linearis W.Smith
Nitzschia microcephala Grun.
Nitzschia obtusa W.Smith
Nitzschia palea (Kütz.) W.Smith
Nitzschia paleacea Grun.
Nitzschia parvula Lewis
Nitzschia recta Hantzsch
Nitzschia sigmoidea (Ehr.) W.Smith
Nitzschia sublinearis Hust.
Nitzschia thermalis Kütz.
Nitzschia vermicularis (Kütz.) Grun.
Pinnularia borealis Ehr.
Pinnularia borealis var. *brevicostata* Hust.
Pinnularia brebissonii (Kütz.) Rabh. var. *brebissonii*
Pinnularia brebissonii var. *diminuta* (Grun.) Cl.
Pinnularia viridis (Nitz.) Ehr. var. *viridis*

Table 7. (Continued).

Placoneis elginensis (Greg.) E.J.Cox
Placoneis exigua (Greg.) Meresch
Reimeria sinuata (Greg.) Kociolek & Stoermer
Rhoicosphenia curvata (Kütz.) Grun. ex Rabh. var. curvata
Rhopalodia gibberula (Ehr.) O.Müll.
Sellophora pupula (Kütz.) Mereschk.
Sellophora pupula var. *elliptica* (Hust.) Poulin
Stauroneis phoenicenteron (Nitz.) Ehr. var. *phoenicenteron*
Stauroneis smithii Grun. var. *smithii*
Surirella angustata Kütz.
Surirella biseriata Breb.
Surirella ovalis Breb.
Surirella ovata Kütz.
Surirella ovata var. *pinnata* (W.Smith) Rabenh.
Surirella spiralis Kütz.
Synedra acus Kütz. var. acus
Synedra delicatissima var. *angustissima* Grun.
Synedra ulna (Nitz.) Ehr. var. *ulna*
Synedra ulna var. *biceps* (Kütz.) Kirchn.
Synedra ulna var. *oxyrhynchus* (Kütz.) Van Heurck
Tryblionella apiculata Greg.

DIVISION: CHLOROPHYTA
CLASS: CHLOROPHYCEAE
ORDER: VOLVOCALES
Chlamydomonas globosa Snow
Chlamydomonas snowii Printz
Eudorina elegans Ehrenberg

ORDER: ULOTRICHALES
Ulothrix sp.
Ulothrix subtilissima Rabenhorst

ORDER: CLADOPHORALES
Cladophora glomerata (L.) Kütz.
Cladophora spp.

ORDER: CHLOROCOCCALES
Actinastrum hantzschii Lagerheim
Ankistrodesmus falcatus var. *acicularis* (A.Braun) G.S.West
Cerasterias staurastroides West & West
Characium falcatum Schroeder
Chlorella vulgaris Beyerinck
Closteriopsis longissima Lemmermann
Crucigenia tetrapedia (Kirch.) West & West
Hydrodictyon reticulatum (L.) Lagerheim
Kirchneriella contorta (Schmidle) Bohlin
Monoraphidium contortum (Thuret in Brebisson) Komarkova
Monoraphidium minutum (Naegeli) Komarkova
Scenedesmus acuminatus var. minor G.M.Smith
Scenedesmus quadricauda (Turp.) de Breb. in de Breb. & Godey
Tetraedron minimum (A.Braun) Hansgirg

CLASS: CONJUGATOPHYCEAE
ORDER: DESMIDIALES
Closterium spp.
Cosmarium botrystis Menegh.

ORDER: ZYGNEMATALES
Spirogyra novae-angliae Transeau
Spirogyra sp.

DIVISION: *CHRYSOPHYTA*
CLASS: CHRYSOPHYCEAE
ORDER: CHRYSOMONADALES
Dinobryon divergens Imhof

DIVISION: *EUGLENOPHYTA*
CLASS: EUGLENOPHYCEAE
ORDER: EUGLENALES
Euglena elastica Prescott
Euglena proxima Dangeard
Euglena sanguinea Ehrenberg
Euglena sp.
Trachelomonas intermedia Dangeard
Trachelomonas volvocina Ehrenberg

DIVISION: *CRYPTOPHYTA*
CLASS: CRYPTOPHYCEAE
ORDER: CRYPTOMONADALES
Cryptomonas ovata Ehrenberg

DIVISION: CYANOPHYTA
CLASS: MYXOPHYCEAE
ORDER: CHROOCOCCALES
Aphanothece clathrata G.S.West in West & West
Dactylococcopsis smithii Chodat & Chodat
Merismopedia tenuissima Lemmermann

ORDER: HORMOGONALES
Anabaena affinis Lemmermann
Aphanizomenon sp.
Lyngbya epiphytica Hieronymus in Engler & Prantl
Lyngbya foveolarum (Gom.) Hansg.
Nostoc entophytum Born. & Flah.
Oscillatoria angustissima West & West
Oscillatoria formosa Bory.
Oscillatoria limnetica Lemmermann
Oscillatoria limosa (Roth) C.A.Agardh
Oscillatoria spp.
Oscillatoria tenuis C.A.Agardh
Phormidium tenue (Menegh.) Gomont
Plectonema nostocorum Bornet
Spirulina laxa G.M.Smith
Spirulina laxissima G.S.West

Bacillariophyta group. Members of the *Chlorophyta* group were represented by low percentages at the third, fourth, fifth and the sixth stations, whereas those of the *Cyanophyta* group became dominant at the fourth, fifth and the sixth stations (Figure 2).

The abundance of epiphytic diatom species is given in Tables 8-9. When the repetition rates of epiphytic diatom species were examined, it was seen that the species *Achnanthidium minutissimum* and *Gomphoneis olivacea* (Lyngb.) Dawson (*Gomphonemaceae*) were consistently present at the first, second, third, fourth and fifth stations, whereas they were mostly present at the sixth station. The species *Cocconeis placentula* Ehr. var. *placentula* (*Achnanthaceae*) and its varieties were mostly present at the fifth station, whereas at the sixth station they were generally present (Table 10).

The species *Amphora perpusilla* (Grun.) Grun. var. *perpusilla* (*Cymbellaceae*) was encountered consistently at the second and the third stations, mostly at the first and the fourth stations, generally at the fifth station and occasionally at the sixth station. The species *Navicula cryptocephala* var. *veneta*, *Nitzschia palea* and *Nitzschia thermalis* Kütz. (*Nitzschiaceae*) were consistently present at all stations, whereas the species

Navicula tripunctata (O.F.Müll.) Bory var. *tripunctata* (*Naviculaceae*) and *Nitzschia dissipata* (Kütz.) Grun. (*Nitzschiaceae*) were consistently present at the first, second and third stations, mostly present at the fourth and fifth stations, and generally present at the sixth station. The species *Gomphonema parvulum* (Kütz.) var. *parvulum* (*Gomphonemaceae*) was consistently present at the first, second, third and sixth stations, while it was mostly encountered at the fourth and fifth stations. The species *Synedra ulna* was mostly present at the first, fourth and fifth stations, whereas it was present generally at the second station, and occasionally at the sixth station (Table 10).

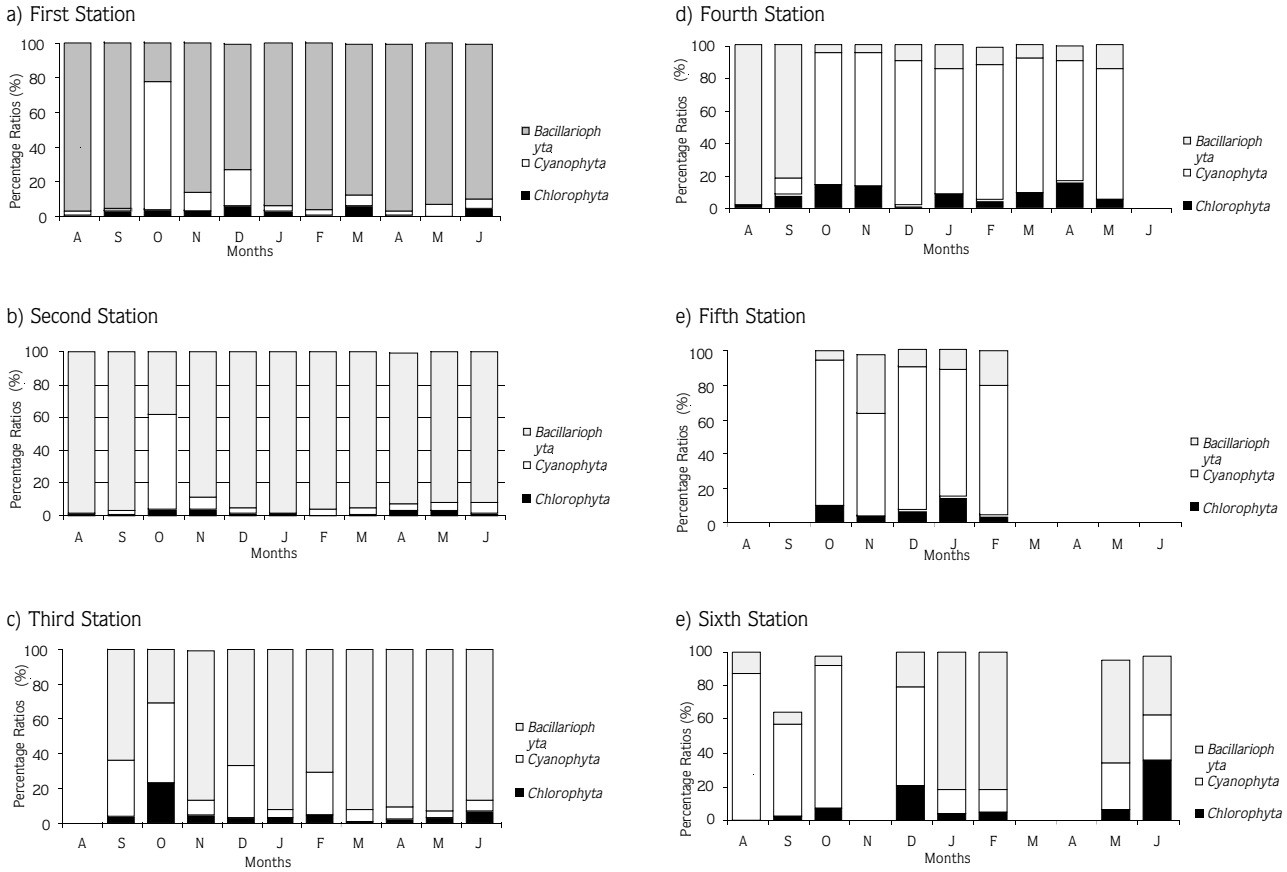

Figure 2. Population Density of Epiphytic Algae Based on Division.

Discussion and Conclusion

One hundred and seventy-three species were identified in our research. Of these, the species belonging to the genera *Achnanthidium, Amphora, Cocconeis, Gomphonema, Gomphoneis, Navicula, Nitzschia* and *Synedra* were widespread in the flora of epiphytic diatoms. The abundance rates of total diatom species varied among stations during the research period (Tables 8-10).

The true dependent algae species belonging to the epiphytic diatom of the Nilüfer stream, such as *Cocconeis placentula, Encyonema minutum, Gomphoneis olivacea, Gomphonema parvulum, Diatoma vulgare* Bory. var. *vulgare* (*Fragilariaceae*), and *Navicula cryptocephala* var. *veneta*, were more frequently found. Similarities were noted among the flora of epipelic, epiphytic and epilithic diatoms. In research by Aykulu (1982), it was stated that although mixes were less common in epipelic, epiphytic

Table 8. The abundance of epiphytic diatoms (Numbers are the existence frequencies of each species in 100 diatoms).

Date	August 97					September 97					October 97						November 97					December 97					
Station Number	1	2	3	4	6	1	2	3	4	5	1	2	3	4	5	6	1	2	3	4	5	1	2	3	4	5	6
Diatom species																											
Achnanthidium minutissimum	16	2	.	3	.	36	10	+	6	+	19	7	7	11	7	4	13	9	3	5	+	50	2	5	.	3	5
A. lanceolatum	9	.	.	.	.	6	.	.	.	.	4	2	+	+	2	+	+	+	+	2	+	+	+	+	6	.	.
A. lanceolatum var. elliptica	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Amphora ovalis	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
A. perpusilla	+	+	.	.	.	2	2	.	.	.	.	+	2	4	.	.	+	3	3	+	.	+	4	2	+	3	.
A. veneta	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	+	.	.	+	+	.	+
Asterionella formosa	.	+	.	+	.	.	+	.	+	+	.	.	2	4	2	.	.	.	+	.	+	+	.	+	+	.	.
Aulacoseira granulata	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	+	.	.	.	.	.	.
A. granulata var. angustissima	.	+	.	.	.	.	.	.	.	.	.	.	+	+	4	+	.	.	+	.	+	.	.	.	+	.	.
A. italica subsp. subarctica	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.
Caloneis bacillum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.
C. ventricosa var. truncatula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cocconeis pediculus	2	7	.	+	.	+	2	.	.	.	.	+	+	2	7	2	.	.	.	.	.	.	.	+	2	2	.
C. placentula	10	12	.	3	.	8	5	.	.	.	7	3	2	7	5	2	+	.	.	+	.	3	2	5	3	3	+
C. scutellum	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Craticula cuspidata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyclotella glomerata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	2	+
C. meneghiniana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	.	.	4	7	5	6
C. ocellata	.	.	.	.	.	+	.	.	.	.	+	.	+	4	.	2	.	.	.	.	.	.	.	2	+	.	8
Cymatopleura solea	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cymbella affinis	.	3	.	.	+	+	+	.	.	.	.	+	.	.	.	+	+	+	+	.	.	.	+	2	+	.	.
C. cistula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
C. cymbiformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
C. lanceolata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
C. microcephala var. crassa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Diatoma ehrenbergii	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	2	.	.	.	.	.	.	.	+	.	.	.
D. hiemale var. mesodon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	+	.
D. vulgare	.	+	.	+	.	.	23	.	.	.	.	+	.	+	3	+	.	.	.	.	.	.	+	+	2	2	+
Diploneis elliptica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Encyonema auerswaldii	.	.	.	.	.	.	.	.	.	.	.	+	2	2	+	.	.	.	.	.	.	.	+	.	+	+	+
E. minutum	2	+	.	+	+	+	+	.	+	.	+	+	.	.	.	+	2	.	+	.	.	+	2	.	.	+	.
E. prostratum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.
E. silesiacum	.	.	.	.	.	+	.	.	.	.	7	2	.	.	2	+	7	.	+	.	+	.	.	.	.	.	.
Epithemia adnata	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eunotia praerupta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fallacia pygmaea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Fragilaria crotonensis	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
F. intermedia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fragilaria sp.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	+	.	3	2
F. vaucheriae	.	.	.	.	.	.	.	.	.	.	.	11	.	+	4	.	.	+	.	.	.	.	.	+	2	.	3
Gomphoneis olivacea	+	.	.	.	.	2	3	.	.	+	3	7	4	2	3	6	11	12	6	9	+	2	3	2	+	+	+

Table 8. (Continued) The abundance of epiphytic diatoms.

Date	August 97					September 97					October 97						November 97					December 97				
Station Number	1	2	3	4	6	1	2	3	4	5	1	2	3	4	5	6	1	2	3	4	5	1	2	3	4	5	6
G. olivacea var. calcarea	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	.	+	+	.	+	+	+
Gomphonema abbreviatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
G. acuminatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
G. angustatum	.	.	.	.	.	.	.	.	.	.	2	+	+	.	.	.	3	.	.	.	.	6	.	.	.	.	.
G. olivaceum var. minutissima	5	4	.	+	.	+	4	+	.	.	6	+	+	+	+	.	3	.	+	2	+	5	+	+	3	.	.
G. parvulum	5	5	.	.	.	+	+	+	+	.	2	3	3	.	2	3	4	+	+	2	.	3	2	8	7	6	4
Gyrosigma acuminatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	+
G. exile	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hannaea arcus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
H. arcus var. amphioxys	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.
Hantzschia amphioxys	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Luticola mutica var. binodis	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melosira varians	.	5	.	.	.	.	7	.	.	.	.	2	2	+	+	+	+	+	+	.	+	+	+	2	+	+	2
Meridion circulare	3	+	.	.	.	+	.	.	.	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Navicula arvensis	.	.	.	.	.	.	+	+	.	.	.	.	+	.	.	.	+	+	3	+	.	.	+	+	+	+	.
N. capitata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N. contempta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.
N. cryptocephala	12	5	.	2	.	4	3	2	+	+	3	2	+	3	6	5	7	+	2	5	.	+	3	7	8	9	4
N. cryptocephala var. intermedia	+	7	.	+	.	+	5	.	.	.	.	4	2	.	+	.	.	+	+	.	.	.	3	+	+	+	.
N. cryptocephala var. veneta	15	10	.	.	+	9	6	+	.	.	21	14	14	5	4	4	17	34	21	10	+	6	23	13	5	3	11
N. cryptotenella	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	2	.	.	.	.	+	.	.	+	.
N. gregaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.
N. lanceolata	2	+	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Station Number	1	2	3	4	6	1	2	3	4	5	1	2	3	4	5	6	1	2	3	4	5	1	2	3	4	5	6
N. menisculus	.	.	.	.	.	+	.	.	.	.	2	+	+	.	+	.	+	+	+	.	.	.	.	.	.	.	.
N. radiosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
N. tripunctata	2	10	.	.	.	+	6	.	.	.	3	16	3	+	3	2	4	4	3	3	.	+	13	11	4	11	3
N. viridula	+	+	.	.	.	2	2	.	.	+	2	8	+	2	2	.	+	4	.	.	.	2	10	.	+	.	.
Neidium affine	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N. binode	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nitzschia acicularis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N. amphibia	.	.	.	+	.	.	.	.	.	.	+	+	+	3	.	.	.	.	.	2	.	2	11	8	6	11	3
N. dissipata	+	+	.	.	+	+	+	3	.	+	.	2	+	3	2	.	+	6	+	2	+	+	4	+	+	.	.
N. filiformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.
N. frustulum var. perpusilla	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	2	.	.	.	.	.	.		.
N. holsatica	+	3	.	16	.	+	2	8	17	+	+	2	2	2	2	8	2	3	+	5	7	+	+	.	2	.	2
N. linearis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
N. microcephala	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	7	+	2	.	.	.	.	+	.	+
N. obtusa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N. palea	4	4	.	56	13	4	3	79	68	4	3	5	16	18	16	21	2	3	20	37	64	2	2	7	12	12	23
N. paleacea	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	+	.	.	.	+	2	+
N. parvula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	+
N. recta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N. sigmoidea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N. sublinearis	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	3	2	+	.	.	.	.	.	.	.	.
N. thermalis	2	2	.	6	81	3	3	+	3	88	+	+	.	.	2	7	+	+	+	+	7	+	+	+	+	+	3
N. vermicularis	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Pinnularia borealis brevicostata	.	.	.	.	.	.	.	.	.	.	+	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
P. brebissonii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P. brebissonii var. diminuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			.	.	.
P. viridis	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Placoneis exiqua	.	.	.	+	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Reimeria sinuata	4	+	.	+	.	3	+	.	.	.	+	+	+	.	2	2	+	.	.	+	.	+	.	.	+	.	+
Rhoicosphenia curvata	.	6	.	.	+	+	2	.	.	.	+	+	2	+	.	.	.	.	.	+	+	+	+	.	+	+	.
Rhopalodia gibberula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 8. (Continued) The abundance of epiphytic diatoms.

Date	August 97					September 97					October 97					November 97					December 97					
Station Number	1	2	3	4	6	1	2	3	4	5	1	2	3	4	5	6	1	2	3	4	5	1	2	3	4	5	6
Sellophora pupula	.	.	.	+	.	.	.	.	.	.	+	+	+	+	.	+	.	.	.	.	+	+	+	.	.	.	.
S. pupula var. elliptica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Stephanodiscus niagarae	.	.	.	.	.	.	.	.	.	.	.	.	2	7	3	5	.	.	6	4	+	.	.	+	3	3	5
Surirella angustata	.	.	.	.	.	+	+	.	.	.	.	+	+	.	.	.	.	.	+	+	+	+	.	+	+	.	.
S. ovalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
S. ovata	.	+	.	.	.	+	+	.	.	.	.	.	.	+	.	.	+	2	7	+	+	.	+	.	.	.	.
S. ovata var. pinnata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Synedra acus	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	+
S. delicatissima var angustissima	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	+	+	4	.
S. ulna	+	2	.	2	.	+	+	.	.	.	.	+	+	+	4	6	+	.	.	+	.	+	.	+	2	5	.
S. ulna var. biceps	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
S. ulna var. oxyrhynchus	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tryblionella apiculata	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.	.

Table 9. The abundance of epiphytic diatoms (Numbers are the existence frequencies of each species in 100 diatoms).

Date	January 98						February 98						March 98				April 98				May 98					June 98			
Station Number	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	1	2	3	4	1	2	3	4	6	1	2	3	6
Diatom species																													
Achnanthidium minutissimum	18	5	+	3	2	+	6	9	7	5	2	+	13	22	9	4	50	27	9	10	30	32	12	16	+	32	17	4	.
A. lanceolatum	+	.	.	3	+	.	+	2	.	+	.	.	+	+	+	+	+	3	+	+	4	+	+	.	+	3	+	+	.
A. lanceolatum var. elliptica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Amphora ovalis	.	.	.	.	2	+	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
A. perpusilla	+	2	+	+	4	2	.	+	6	+	2	.	.	+	2	.	+	2	+	2	+	+	2	.	+	.	4	+	.
A. veneta	.	+	+	+	.	+	+	+	.	.	2	+	.	.	.	+	.	.	+	2	+	.	.	+	+	.	.	.	.
Asterionella formosa	.	.	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	3	.	+	+	.	.	.
Aulacoseira granulata	.	.	+	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
A. granulata var. angustissima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
A. italica subsp. subarctica	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Caloneis bacillum	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
C. ventricosa var. truncatula	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cocconeis pediculus	.	.	+	+	+	+	.	+	3	+	+	+	.	.	+	2	.	+	+	+	.	+	+	3	.	.	14	5	2
C. placentula	2	+	2	+	+	+	+	3	+	4	2	.	.	.	+	2	.	.	+	.	.	+	+	+	.	3	12	.	.
C. scutellum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.
Craticula cuspidata	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyclotella glomerata	.	+	2	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
C. meneghiniana	.	.	+	+	+	+	.	.	+	2	3	4	.	.	.	+	.	.	.	+	.	.	+	2	3	.	.	.	5
C. ocellata	.	.	.	+	+	.	.	.	+	5	+	2	.	.	.	+	.	.	+	9	.	.	2	2	+	.	.	.	.
Cymatopleura solea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cymbella affinis	.	.	+	+	.	.	.	+	+	+	+	.	+	.	+	.	+	+	+	.	+	+	.	+	.	+	+	+	.
C. cistula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
C. cymbiformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
C. lanceolata	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
C. microcephala var. crassa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diatoma ehrenbergii	+	.	6	11	14	+	+	+	4	3	2	.	.	.	4	3	.	+	5	3	.	.	.	3	.	.	.	.	.
D. hiemale var. mesodon	+	.	.	.	.	.	.	+	.	.	.	+	+	+	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.
D. vulgare	.	4	52	3	2	+	+	2	+	+	.	+	.	+	+	.	.	+	4	.	.	+	.	.	.	+	+	3	+
Diploneis elliptica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Encyonema auerswaldii	.	.	.	.	+	.	.	+	.	+	+	.	.	.	.	.	.	+	.	+	+	.	+	.	.	.	.	+	.
E. minutum	+	.	+	+	+	.	2	+	.	.	.	.	+	.	.	3	.	.	+	.	.	+	.	2	.	+	+	+	.
E. prostratum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	

Table 9. The abundance of epiphytic diatoms (Numbers are the existence frequencies of each species in 100 diatoms).

Date	January 98						February 98						March 98				April 98				May 98					June 98			
Station Number	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	1	2	3	4	1	2	3	4	6	1	2	3	6
E. silesiacum	3	+	.	4	2	.	14	+	+	2	2	.	6	3	.	5	9	4	+	4	12	6	+	2	.	18	+	+	.
Epithemia adnata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eunotia praerupta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Fallacia pygmaea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.
Fragilaria crotonensis	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
F. intermedia	.	.	+	.	+	+	.	.	.	.	.	+	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Fragilaria sp.	10	.	+	5	3	3	+	2	+	+	3	2	4	3	4	5	3	4	5	+	3	+	.	+	.	+	.	.	.
F. vaucheriae	.	.	.	+	.	.	.	.	+	+	.	.	+	.	+	+	.	.	.	.	+	+	.	.	.	.	.	.	.
Gomphoneis olivacea	19	3	+	9	7	3	6	8	8	3	5	.	30	8	18	10	9	12	5	5	8	8	2	+	.	+	+	+	3
G. olivacea var. calcarea	+	.	.	+	+	.	.	.	+	.	.	.	.	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.
Gomphonema abbreviatum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	+	+	+	.	.	.	.	.	.	.	.
G. acuminatum	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
G. angustatum	5	+	.	.	.	+	8	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
G. olivaceum var. minutissima	3	+	+	+	+	+	5	3	.	+	+	+	4	+	.	3	2	2	.	3	+	+	.	.	.	15	8	20	13
G. parvulum	+	+	+	4	2	10	4	3	+	5	6	2	6	+	+	.	2	2	+	+	3	3	2	7	12	5	2	4	12
Gyrosigma acuminatum	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
G. exile	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hannaea arcus	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
H. arcus var. amphioxys	+	.	.	+	.	.	.	+	.	.	.	2	11	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.
Hantzschia amphioxys	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Luticola mutica var. binodis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melosira varians	+	+	2	2	+	+	+	3	3	3	8	+	.	.	8	.	.	.	34	2	.	.	.	.	.	+	4	+	.
Meridion circulare	6	.	.	2	.	.	2	.	+	+	+	+	3	.	.	.	+	+	+	.	+	.	.	.	.	.	.	.	.
Navicula arvensis	+	.	.	.	.	.	.	.	+	+	.	2	.	+	5	+	3	+	+	+	+	+	+	5	.	.	+	.	.
N. capitata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
N. contempta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N. cryptocephala	+	2	+	2	+	+	.	+	2	3	2	2	.	.	+	.	.	.	.	2	+	.	+	2	14	2	+	6	3
N. cryptocephala var intermedia	.	3	+	+	+	.	.	2	3	+	3	+	+	2	4	+	+	4	+	.	+	3	3	+	.	.	3	2	+
N. cryptocephala var. veneta	5	6	2	6	4	2	+	4	16	9	+	10	+	8	10	8	4	5	5	8	5	10	9	13	2	+	5	3	6
N. cryptotenella	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.
N. gregaria	.	3	.	3	3	2	+	+	+	3	.	2	+	+	+	3	+	+	+	8	5	5	.	5	+	.	.	.	.
N. lanceolata	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.
N. menisculus	.	+	.	+	.	.	.	.	+	.	.	.	.	+	+	.	.	+	+	3	+	+	.	.	+	.	.	.	.
N. radiosa	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
N. tripunctata	3	3	3	+	+	+	4	9	15	2	2	+	2	4	+	.	2	4	2	.	3	3	+	+	.	2	5	.	+
N. viridula	.	12	2	+	+	.	26	14	+	.	2	3	+	25	9	5	+	6	4	.	+	3	+	.	.	+	+	.	+
Neidium affine	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.
N. binode	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nitzschia acicularis	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.
N. amphibia	.	.	+	+	4	+	.	.	+	+	+	.	.	.	.	.	.	.	.	3	.	.	+	.	.	.	+	+	3
N. dissipata	+	15	+	.	+	+	+	5	+	2	3	5	2	6	3	+	+	+	+	+	+	3	3	4	.	.	.	.	.
N. filiformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N. frustulum var. perpusilla	.	+	.	.	.	.	+	.	+	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
N. holsatica	.	.	.	+	.	4	.	.	+	+	.	4	.	.	.	.	.	+	.	.	+	+	4	+	3	.	+	4	4
N. linearis	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.
N. microcephala	.	.	+	.	.	.	.	.	+	.	.	.	.	+	+	.	.	.	.	2	.	+	.	+	.	.	+	+	.
N. obtusa	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N. palea	+	12	2	9	11	52	+	5	3	10	15	17	+	5	+	14	+	2	2	19	+	3	41	14	51	+	6	16	34
N. paleacea	+	.	.	+	+	.	.	.	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.	2	.	.	.	.	.
N. parvula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N. recta	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N. sigmoidea	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N. sublinearis	+	.	+	+	+	.	.	+	.	.	2	2	.	.	+	+	.	.	+	.	+	.	.	+	.	.	+	.	.
N. thermalis	+	10	2	3	2	+	+	.	+	6	4	+	+	.	.	.	+	+	.	2	+	+	+	+	+	+	+	.	5
N. vermicularis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 9. The abundance of epiphytic diatoms (Numbers are the existence frequencies of each species in 100 diatoms).

Date	January 98						February 98						March 98				April 98				May 98					June 98			
Station Number	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	1	2	3	4	1	2	3	4	6	1	2	3	6
Pinnularia borealis brevicostata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
P. brebissonii	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P. brebissonii var. diminuta	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P. viridis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Placoneis exiqua	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Reimeria sinuata	.	+	.	2	2	.	+	+	.	+	.	.	.	.	.	.	+	+	+	.	+	3	.	.	.	2	+	11	2
Rhoicosphenia curvata	+	+	+	+	+	.	+	+	+	+	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	4	3
Rhopalodia gibberula	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sellophora pupula	.	+	.	.	+	.	+	+	+	+	.	.	.	.	.	.	.	+	.	.	.	+	.	.	+	.	.	.	.
S. pupula var. elliptica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stephanodiscus niagarae	.	.	.	+	+	.	.	.	+	3	3	8	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Surirella angustata	+	+	+	.	.	.	.	+	.	.	+	8	.	.	.	.	.	.	.	.	+	.	.	+	.	+	+	.	.
S. ovalis	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
S. ovata	+	+	.	2	+	+	4	4	+	+	6	5	3	+	7	9	+	+	3	+	+	+	.	+	+	+	.	.	.
S. ovata var. pinnata	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Synedra acus	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
S.delicatissima var angustissima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	+	.	.	.	.	.
S. ulna	+	+	+	+	5	3	.	+	+	4	7	2	+	.	.	.	.	+	+	+	+	.	+	.	.	+	.	.	.
S. ulna var. biceps	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
S. ulna var. oxyrhynchus	+	.	.	.	+	+	.	.	.	+	.	.	.	.	.	2	.	.	.	.	.	.	.	+	.	.	.	.	.
Tryblionella apiculata	.	.	.	.	+	.	.	.	+	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.

		Sampling stations	1	2	3	4	5	6
		Sampling number	11	11	10	10	6	7
		Organisms						
	Centrales	Aulacoseira granulata	...	...	20	20	33	...
		Aulacoseira granulata var. angustissima	...	9	30	20	33	14
		Aulacoseira italica subsp. subarctica	...	...	30	10	...	...
Bacillariophyta		Cyclotella glomerata	...	9	20	10	33	29
		Cyclotella meneghiniana	...	...	50	60	67	86
		Cyclotella ocellata	18	...	50	70	33	57
		Melosira varians	45	73	80	50	76	57
		Stephanodiscus niagarae	...	...	40	50	67	43
	Pennales	Achnantidium lanceolatum	100	73	70	70	50	29
		Achnantidium lanceolatum var. elliptica	18	...	...	...	...	...
		Achnanthidium minutissimum	100	100	100	90	100	71
		Amphora ovalis	18	9	10	20	33	14
		Amphora perpusilla	64	100	90	60	50	29
		Amphora *veneta*	27	18	40	50	33	57
		Asterionella formosa	18	18	40	60	50	14
		Caloneis bacillum	...	...	...	20	33	14
		Cocconeis pediculus	18	64	80	80	67	57
		Cocconeis placentula	73	73	70	80	76	43
		Cocconeis scutellum	27	...	...	...	...	14
		Craticula cuspidata	...	...	...	...	17	14
		Cymbella affinis	55	82	70	40	17	29
		Cymbella cistula	...	...	...	10	...	...
		Cymbella cymbiformis	...	...	...	10	...	...
		Cymbella lanceolata	...	...	10	...	...	...

Table 10. The frequencies of some epiphytic diatom species (The percentage of the number of samples in which organisms were found to the total number of samples).

100% - 80%: Consistently Present
80% - 60%: Mostly Present
60% - 40%: Generally Present
40% - 20%: Occasionally Present
20% - 1%: Rarely Present

Table 10. (Continued) The frequencies of some epiphytic diatom species.

Bacillariophyta	Pennales	Diatoma ehrenbergii	18	18	50	60	50	29
		Diatoma hiemale var. mesodon	45	18	10	...	17	29
		Diatoma vulgare	9	91	60	50	50	71
		Diploneis elliptica	...	...	10	10	...	13
		Encyonema minutum	82	64	40	50	17	29
		Encyonema silesiacum	82	64	50	50	67	14
		Encyonema prostratum	9	...	10	...	...	...
		Encyonema auerswaldii	9	36	30	40	67	14
		Fallacia pygmaea	...	...	...	10	17	14
		Fragilaria crotonensis	...	...	10	...	17	...
		Fragilaria intermedia	...	...	10	10	17	29
		Fragilaria sp.	64	45	50	60	50	43
		Fragilaria vaucheriae	18	9	50	40	17	29
		Gomphoneis olivacea	100	91	90	80	100	57
		Gomphoneis olivacea var. calcarea	27	27	20	30	50	29
		Gomphonema abbreviatum	27	9	10	10	...	...
		Gomphonema acuminatum	...	...	...	...	17	...
		Gomphonema angustatum	55	18	10	...	...	29
		Gomphonema olivaceum var minutissima	100	91	60	80	76	43
		Gomphonema parvulum	100	100	100	70	67	86
		Gyrosigma acuminatum	...	9	...	10	17	14
		Hannaea arcus	9	9	...	...	...	14
		Hannaea arcus var. amphioxys	27	27	...	30	...	29
		Hantzschia amphioxys	...	...	...	10	...	...
		Luticola mutica var. binodis	...	...	...	10	...	...
		Meridion circulare	82	27	20	20	17	14
		Navicula arvensis	36	64	80	60	17	14
		Navicula capitata	...	...	10	...	...	...
		Navicula contempta	...	9	10	...	...	...
		Navicula cryptocephala	73	73	90	90	76	86
		Navicula cryptocephala var. intermedia	45	100	90	60	76	29
		Navicula cryptocephala var. *veneta*	100	100	100	80	100	100
		Navicula exigua var. capitata	9	...	...	10	...	...
		Navicula gregaria	36	45	40	50	33	43
		Navicula lanceolata	36	18	...	...	...	14
		Navicula menisculus	36	55	50	20	17	14
		Navicula pupula	27	55	20	30	33	29
		Navicula pupula var. elliptica	...	...	...	...	17	14
		Navicula radiosa	...	18	10	...	...	...
		Navicula cyrptotenella	18	45	10	...	17	...
		Navicula tripunctata	100	100	80	60	76	71
		Navicula viridula	91	100	60	40	67	29
		Neidium affine	18	9	10	...	...	...
		Neidium binode	...	9	...	10	...	...
		Nitzschia acicularis	...	...	...	30	...	14
		Nitzschia amphibia	18	27	60	70	50	43
		Nitzschia dissipata	91	91	90	70	76	57
		Nitzschia filiformis	...	...	...	...	17	14
		Nitzschia frustulum var. perpusilla	18	18	30	20	...	...
		Nitzschia gracilis	...	...	...	...	...	14
		Nitzschia holsatica	55	73	60	80	50	86
		Nitzschia linearis	9	...	10	20	...	...
		Nitzschia microcephala	...	45	50	40	...	14
		Nitzschia obtusa	...	9	...	...	17	...
		Nitzschia palea	100	100	100	100	100	100

Table 10. (Continued) The frequencies of some epiphytic diatom species.

		Nitzschia paleacea	18	...	10	40	67	29
		Nitzschia parvula	...	...	...	10	17	14
		Nitzschia recta	...	9	10	10	...	...
		Nitzschia sigmoidea	9	...	10	...	...	...
		Nitzschia sublinearis	45	27	40	40	17	14
		Nitzschia thermalis	100	82	60	80	100	100
B		Nitzschia vermicularis	9	...	10	...	...	...
a		Nitzscia acicularis	...	...	20	...	17	...
c		Pinnularia borealis	...	18	...	...	...	...
i	P	Pinnularia borealis var. brevicostata	9	9	...	10	...	...
l	e	Pinnularia brebissonii var. diminuta	18	...	...	...	...	...
l	n	Pinnularia viridis	18	...	...	...	...	...
a	n	Placoneis elginensis	...	...	...	10	...	...
r	a	Placoneis exigua	18	9	...	10	...	14
i	l	Reimeria sinuata	82	73	30	40	33	43
o	e	Rhoicosphenia curvata	64	64	40	50	50	43
p	s	Stauroneis phoenicenteron	...	...	...	...	...	14
h		Stauroneis smithii	...	...	...	...	17	...
y		Surirella angustata	45	45	40	30	33	14
t		Surirella biseriata	...	...	10	...	...	...
a		Surirella ovalis	18	...	...	...	...	...
		Surirella ovata	73	82	40	70	50	43
		Surirella ovata var. pinnata	9	9	...	10	...	...
		Synedra acus	9	...	10	20	17	14
		Synedra delicatissima var. angustissima	...	...	40	30	33	...
		Synedra ulna	73	55	60	70	76	43
		Synedra ulna var. biceps	...	...	10	...	17	...
		Synedra ulna var. oxyrhynchus	9	9	...	30	17	14
		Tryblionella apiculata	9	...	30	10	33	...

and epilithic flora in slow-flowing and relatively deep rivers, there were more mixes in fast-flowing and small streams. This opinion was in accordance with our results. The pH of the Nilüfer stream was between the ranges of 7.1 and 8.8, exhibiting an alkaline nature (Tables 1-6). In our research, the species *Encyonema minutum*, *Achnanthidium minutissimum*, *Navicula cryptocephala*, *Navicula cryptocephala* var. *veneta*, *Nitzschia palea*, and *Synedra ulna* were observed intensively. These species were also recorded in the rivers with alkaline characteristics in Turkey (Yıldız, 1987a, 1987b; Altuner and Gürbüz, 1991; Gönülol and Arslan, 1992). The fact that Round (1981) stated that these species were abundant in waters with alkaline characteristics supports our results.

The species *Cocconeis placentula, Gomphoneis olivacea, Reimeria sinuata* (Greg.) Kociolek & Stoermer (*Cymbellaceae*), and *Gomphonema parvulum*, which are members of attached epiphytic algae communities, are common in the rivers in Turkey investigated so far (Yıldız, 1984b, 1987a, 1991; Altuner and Gürbüz, 1991). They were found together with the species *Achnanthidium minutissimum*, *Navicula cryptocephala* and *Nitzschia palea*, which spread in the epipelic algal flora attached with musilage stalks.

Gradual pollution effects in the Nilüfer stream were demonstrated by biological parameters, as well as by all physical and chemical parameters. The fact that the dissolved oxygen fell under 3 mg/l at the fourth, fifth and sixth stations and the BOD_5 values increased gradually at all the stations shows the degree of pollution (Tables 1-6).

According to Yılmaz et al. (1998), chromium and lead concentrations were above the standard limits given for the heavily polluted class of water at the stations called Geçit, Göbelye, Hayırlar and Ekmekçi between 1991 and 1994. The results of this study when compared with those of the Bursa Environment Project carried out between 1989 and 1991, show that nitrogen and phosphorus constituents and BOD_5 load were almost

double the 1989 to 1991 values (Yılmaz et al., 1998). COD input seems to increase almost six times during the same previous period and values showing the industrial inputs (Yılmaz et al., 1998).

Epiphytic algae act as primary producers in the nutrition chain in rivers. In our study, it was observed that the numerical value of the epiphytic algae species known to be pollution indicators increased. The species *Nitzschia palea, Gomphonema parvulum, Euglena viridis, Oscillatoria limosa* and *Oscillatoria tenuis*, known to be pollution indicators, increased at the stations affected by pollutants (Palmer, 1969). Therefore, the presence of pollution in the Nilüfer stream was proved by biological parameters, as well as by all physical and chemical parameters.

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