# Phytoplankton and seasonal variations of the River Yeşilırmak, Amasya, Turkey

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**Abstract**

Seasonal variations of the phytoplankton of the River Yeşilırmak were studied between June 1999 and May 2000. Similiar seasoanl variations were observed at stations 1, 2 and 3 whereas at station 4 seasonal variations of total organism numbers were completely different untill November then similiar developments to other stations were observed. Bacillariophyta dominated in plankton of the River Yeşilırmak. The number of species of other division were found to be less. *Navicula cincta, N. cryptocephala* and *N. rhyncocephala* significantly increased in St1., St2. and St3. in July, September, December and January. Algal members were rather low in February, March, April and no algae were found in January and March due to rainfall.

*Key Words:* Algae, phytoplankton, river, pollution, seasonal variation.

## Introduction

Although Turkey has great potential of inland water relatively is known about their algal flora. It is necessary to study the algal flora of Turkey as part of the biological monitoring requested by the European Water Framework Diective and also the investigation of the feshwater algal flora. However algae might be used as indicators of water quality.

First studies on the algae of the River Yeşilırmak were made in the city center of Tokat. In these studies diatome flora (Altuner and Pabuçcu, 1996), planktonic algal flora (Pabuçcu and Altuner, 1998) and bentic algal flora (Pabuçcu *et al*., 1999a) of the River Yeşilırmak were investigated. And also the algal flora and ecology of Suat Uğurlu Dam lake (Yazıcı and Gönülol, 1994), algal flora and seasonal variations of Hasan Uğurlu Dam lake (Gönülol and Obalı, 1998) which was built on the River Yeşilırmak were investigated.

Algae that forms source of food and oxygen for heterotrof organisms in aquatic habitats affect directly primary productivity by forming first circle of food chain. And also it's reported that the algae have a role in determining water pollution and cleaning waste water (Çolak and Kaya, 1988). In recent years algal indicators are effective in checking and observing tools. If the chemical monitoring is limited, the use of diatoms in monitoring would be valuable in remote locations subtect to the pronounced change (Jüttner *et al*., 1996).

### Study Area

The River Yeşilırmak originates at an altitude of 2801m at the western slope of Köse Mountain and flows into the Black Sea at the plain of Çarşamba-Samsun. Kelkit, Çekerek, Mecitözü and Tersakan are the tributries of the River Yeşilırmak.

The River Yeşilırmak basin includes masses of various kinds in different times. These masses are the third age sediments, masses of crystal structure and alluvions. The Yeşilırmak includes a lot of sediment loading by solving and breaking matters within the sand while passing (Tekin, 1997).

The climate regime in the area is characterised by the transition from the climate of the Middle Black Sea Region to that of Central Anatolia.The data used was obtained from the meteorology station in Amasya. In Amasya the average temperature between 1967 and 1999 was 13.9°C and the average minimum temperature was –0.6°C in December. The annual average rain was 397.5 mm (Anonymous, 2000).

The four sites sampled are shown on Figure 1. St1. is situated about 2 km away from city center on the way to Tokat. It is covered with thin sandy sediments. Population densities are low in here and this place was free from seawage inputs but agricultural runoff influence the River Yeşilırmak. St2. is within the city center of Amasya, near the city stadium. Population densities were high and they discharge sewage directly. The river is affected by seawage. Sampling area is covered with trees in the bush form and the ground is shadowed by those trees. St3 is in the city center of Amasya, near to a bridge in İstasyon Street. There are fruit trees on both sides of the river and clacy sand ground. Population densities are high in here and aggreing what was pointed out by Jenkins *et al*., 1995 and Jüttner *et al*., 1996 untreated seawage input leads to organic enrichment and deoxydations and agricultural run off from fertilizers increases nutrient loadings. St4. is situated about 2 km away from city center near the Ziyaret Bridge. There

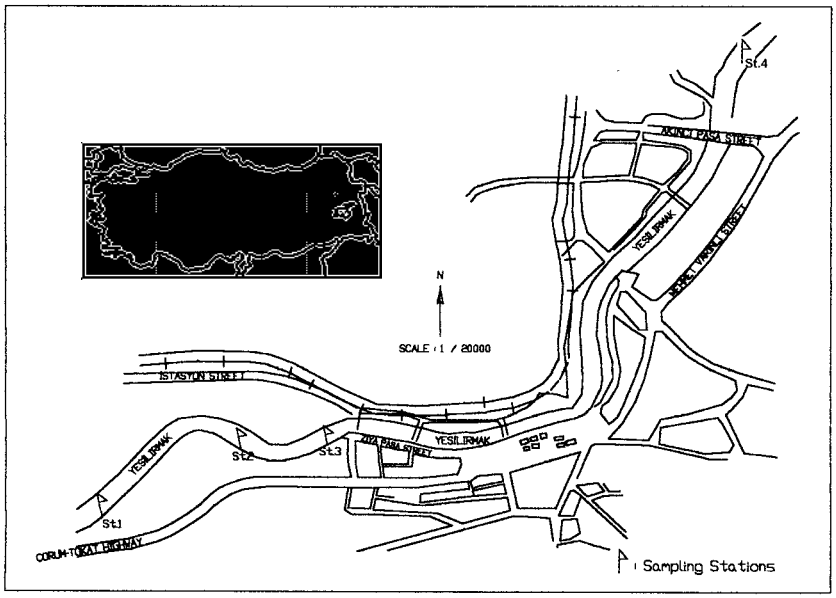


**Figure 1.** Map of the studied area

are fruit trees on both sides of the river and stony sand ground.

## Materials and Methods

The four stations along the river were sampled between June 1999 and May 2000. Samples of surface water were collected montly with an 2 litre bottle to determine the density of the algae in the river. They were fixed and preserved with 10% Lugol solution. The algae were identified and counted in the counting tubes using an inverted microscope according to the method of Lund (1958). In the evaluations, the average of three countings from each station was used. In the counting process every colony and threadlike organism was considered to be an individual unit. The remaining part of the water sample was filtered using Whatman GF/A glass fibre filter paper with a pore size of 55 μm and the residue on the filter paper was used to identify the algae except Bacillariophyta. Bacillariophyta members were identified on permanent slides which had been prepared according to the method of Round (1953).

For the idetification of algal species Krammer and Lange-Bertalot 1986; 1991a; 1991b; 1999; Komarek *et al*., 1998; Huber Pestalozzi, 1969; 1972, 1983 were used. And also all the species are checked in algaebase cite (Guiry and Nic Dhonncha, 2003).

## Results

A total of 47 taxa was found in the plankton of the River Yeşilırmak throughout the study period. Bacillariophyta were the richest taxonomic group with 31 taxa, followed by Euglenophyta (6 taxa), Cyanoprokaryota (6 taxa) and Chlorophyta (4 taxa). List of algae present in the phytoplankton and their occurence at the stations were given in Table1.

Total organism numbers have almost show similiar seasonal variations at St1., St2. and St3. In St4 there was an continual increase in total organism numbers till November and then similiar developments to other divisions were observed.

Phytoplanktonic richness decreased in February and April. The lowest values occured with 75 org/cm$^3$ at St2. and with 50 org/cm$^3$ at St1. There was a few decrease in total organism numbers at St4 in May compared to increases at other stations. Total organism numbers reached its maximum level (17,450 org/cm$^3$) at St3 in September (Figure 2).

Bacilariophyta dominated in the plankton of the River Yeşilırmak. The number of species of other divisions species were present significantly lower numbers. And also in the plankton only Bacillariophyta division always recorded at all stations and showed seasonal variations. The other algae divisions increased in distinct months at different stations and didn't find continual to show seasonal variations (Figure 3). Algal numbers were present rather low in February, March, April May and no algae were found in January and March due to rainfall.

*Nitzschia* spp., and *Navicula* were always recorded in St2. and St3, usually in St1 and St4. *Fagilaria* spp. was found usually in St1, St2, and St3, sometimes in St1. Other pennat diatoms were recorded sometimes.

*Gomphonema* spp., *Cymatopleura solea*, *Rhoicosphaneia curvata*, *Pinnularia* spp. and *Surirella* spp. were found to be rare at the sampling stations. Melosira varians, a centric diatom, was

**Table 1.** List of algae present in the phytoplankton and their occurence in the stations.

| | St.1 | St. 2 | St.3 | St.4 |
|---|---|---|---|---|
| **Cyanoprokaryota** | | | | |
| *Anabaena catenula* **(**Kütz) Born. et Flah. | * | | * | * |
| *Anabaena sp.* | | * | | |
| *Arthrospira major* (Kütz.) Crow | * | | | |
| *Cylindrospermum stagnale* (Kütz.) Born. et Flah. | | | * | * |
| Phormidium tenue *Anagnostidis & Komarek* | | | | * |
| *Pseudoanbaena limnetica* (Lemm.) Komarek | | | * | |
| **Bacillariophyta** | | | | |
| *Cocconeis pediculus* Ehr. | * | * | * | * |
| *Cocconeis placentula* (Ehr.) Cleve | * | * | * | * |
| *Cyclotella ocellata* Pant. | * | * | * | * |
| *Cymatopleura solea* (Breb.) W. Smith | * | * | * | * |
| *Cymbella affinis* Kütz. | * | * | * | * |
| *Cymbella ventricosa* C. Agardh | * | * | * | * |
| *Diatoma vulgaris* Bory | * | | | * |
| *Fragilaria ulna* var. *acus* (Kütz.) Lange -Bertalot | * | * | * | |
| *Fragilaria ulna* (Nitz.) Lange Bertalot | * | * | * | * |
| *Gomphonema olivaceum* (Lyngb.) Kütz. | * | * | * | * |
| *Gomphonema parvulum* (Kütz.) Grun. | | | | * |
| *Gyrosigma acuminatum* (Kütz.) Rabh. | * | * | * | * |
| *Gyrosigma scalproides* ***(Rabh.)*** Cleve | | * | * | * |
| *Melosira varians* C. Agardh | | | | * |
| *Navicula capitatata* Ehr. var. *hungarica* (Grun.) Ross | * | * | * | * |
| *Navicula cincta* (Ehr.) Ralfs | * | * | * | * |
| *Navicula cryptocephala* Kütz. | * | * | * | * |
| *Navicula cuspidata* Kütz. | * | * | * | * |
| *Navicula radiosa* Kütz. | * | * | * | |
| *Navicula tripunctata* (O. F. Müler) Bory | * | * | | |
| *Navicula rhyncocephala* Kütz. | * | * | * | * |
| *Nitzschia acicularis* (Nitz.) W. Smith | * | * | * | * |
| *Nitzschia amphibia* Grun. | * | * | * | * |
| *Nitzschia constricta* (Nitz.) W. Smith | * | * | * | * |
| *Nitzschia palea* (Kütz.) W. Smith | * | * | * | * |
| *Nitzschia sigmoidea* (Nitz.) W. Smith | | * | * | * |
| *Nitzschia vermicularis* (Kütz.) Hant. | | * | * | * |
| *Pinnularia brebissonii* (Kütz.) Rabh. | | | * | |
| *Rhoicosphenia curvata* (Kütz.) Grun. | * | * | | * |
| *Surirella brebissonnii* Krammer *&* Lange - Bertalot var. *kuetzingii* Krammer *&* Lange - Bertalot | * | | * | * |
| *Surirella ovalis* Breb. | * | * | * | |
| **Chlorophyta** | | | | |
| *Crucigenia quadrata* Morren | | | | * |
| *Pandorina morum* (O. F. Müller) Bory | | * | | |
| *Scenedesmus acuminatus* (Lager.) Chod. | | * | | * |
| *Spirogyra ellipsospora* Transeau | | | * | |
| **Euglenophyta** | | | | |
| *Euglena acus* Ehr. | | * | * | |
| *Euglena deses* f. *major* Popowa | * | * | * | * |
| *Euglena minuta* Prescot. | * | * | * | * |
| *Euglena satelles* Brasl.-Spect. | | | * | * |
| *Phacus arnoldi* Swir. | | | | * |
| *Trachelomonas hispida* (Perty) Stein. | * | * | * | |

found rarely only in St1., *Cyclotella ocellata* in St1., St3 and St4 and the same species were recorded sometimes in St2.

*Navicula cincta*, *N. cryptocephala* and *N. rhyncocephala* significantly increased in St1., St2 and St3. in July, September, December and January. Although these species were dominant in St4, they didn't become abundant. The seasonal variations of *Navicula* spp. and some of other species is shown in Figure 4.

Chlorophyta division was represented by only four species (*Scenedesmus acuminatus*, *Crucigenia quadrata*, *Pandorina morum*, *Spirogyra varians*) in the plankton. These species were recorded scarcely and algal numbers of these species were very low. *Anabaena catenula* from Cyanoprokaryota showed increase in St1., St3. and St4. in November, in St2. in September and November. This species was recorded rarely or not in other months.

Euglenophyta never reached high levels in the study period. Only *Euglena deses* f. *major* numbers showed slight increases in September and January.

## Discussion

Bacillariophyta were also dominant in the studies of other Turkish rivers (Altuner, 1988; Altuner and Gürbüz, 1989; Arslan and Gönülol, 1992; Altuner and Pabuçcu, 1996). Pennate diatoms were dominant The most common species were *Nitzschia palea,*

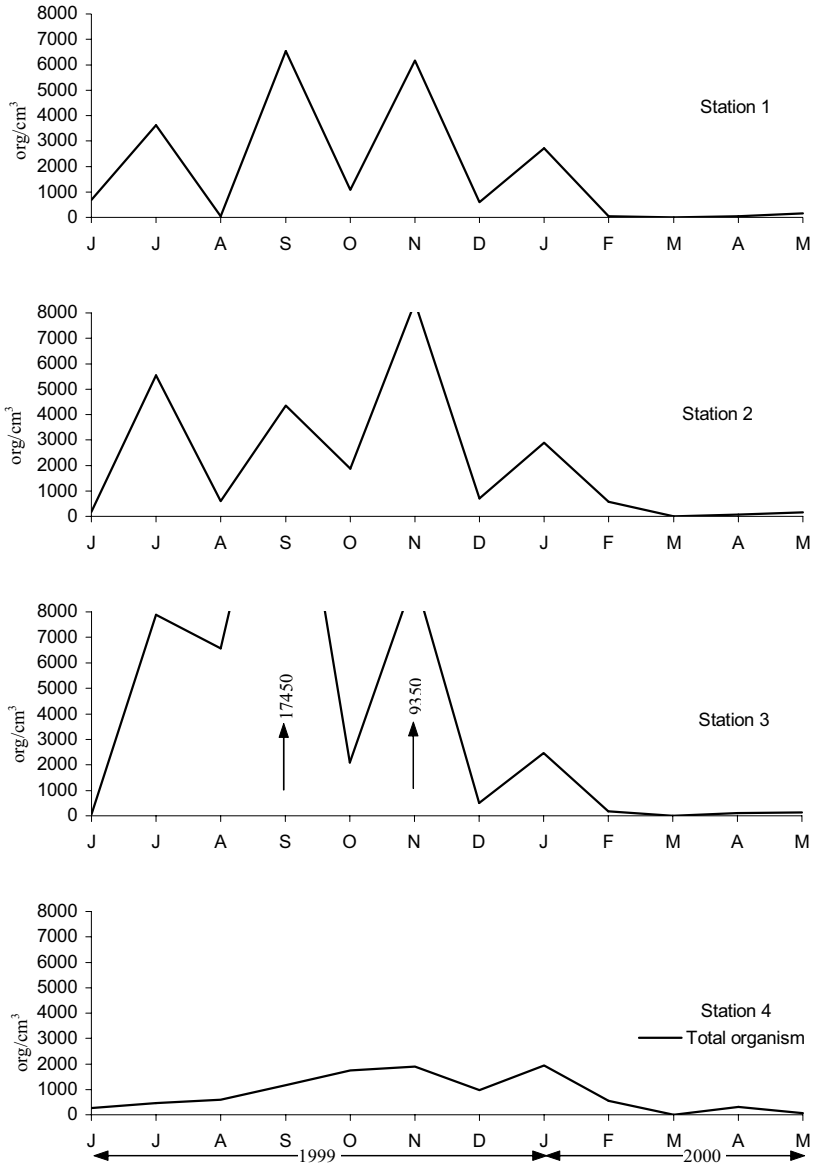


**Fig.2.** The seasonal variations of total organisms in the sampling stations.

*Navicula cincta, N. rhyncocephala, N. cryptocephala* and *Fragilaria ulna.* While centric diatoms were found in less numbers in the studies of Turkish Rivers such as: Meram Stream (Yıldız, 1984), Porsuk (Yıldız, 1987a; 1987b), İncesu (Arslan and Gönülol, 1992), Göksu (Albay and Aykulu, 1994) and Çekerek Rivers (Pabuçcu and Altuner, 1999b), Pennat diatoms such as *Nitzschia* and *Navicula, Fragilaria, Gomphonema* and *Cocconeis* were dominant organisms. Whereas in the rivers of England (Lack, 1971), Belgium (Gosselain *et al*., 1994) and Germany (De Ruyter von Stevenick, 1990; Bahnwart *et al*., 1999) which were in the same temperate zone with Turkey, centric diatoms were dominated.

Although *Fragilaria ulna* and *Nitzschia palea* were abundant and common in Meram Stream (Yıldız, 1984), the same species were found in less numbers in the rivers of Kızılırmak (Yıldız and Özkıran, 1991) and Porsuk (Yıldız, 1987b). *Achnanthes lanceolata, Amphora ovalis, Cymbella affinis, Navicula cryptocephala, Nitzschia palea* and *Fragilaria ulna* that's indicated to live on sediments and refer to alkalin waters (Round, 1984) found to be common in the plankton of our study area. And it is indicated that in a study of the River Yeşilırmak (Tokat) these species were also found to be spread (Pabuçcu and Altuner, 1998).

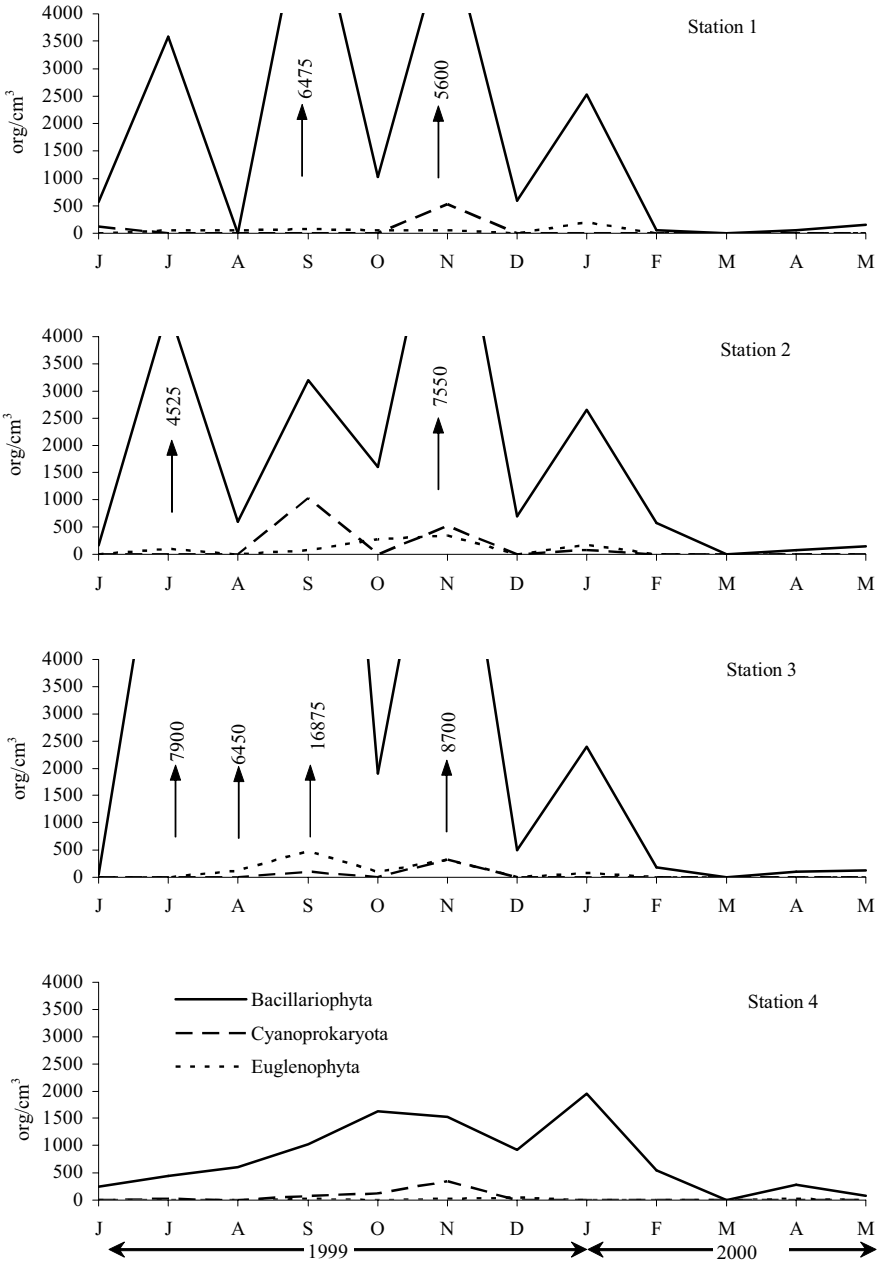


**Figure 3.** The seasonal variations of total Bacillariophyta, Cyanoprokaryota and Euglenophyta.

*Fragilaria ulna, Surirella brebissonii* var *kuetzingii* and *Navicula cryptocephala* are charecteristical species of affected waters by seawage inputs and these organisms were found to be abundant in eutrof waters (Albay and Aykulu, 1994). To find these species in our study area brings up the matter of eutrofication of the river.

Cyanoprokaryota division is represented by *Anabaena* spp., *Cylindrospermum stagnale* and *Arthrospira major.* These species were found to be rare and scarcely. The same species except *Cylindrospermum stagnale* were also recorded in the River Karasu (Fırat) (Altuner and Gürbüz, 1989), the river basin of Köprüköy-Deli Çermik (Altuner and Pabuçcu, 1993), the River Seyhan (Adana) (Çevik *et al*., 1994) and Yeşilırmak (Tokat) (Pabuçcu and Altuner, 1998). These rivers include not only the species of Hormogonales ordo and also Chlorococcales.

*Crucigenia quadrata, Scenedesmus acuminatus, Spirogyra ellipsospora* and *Cosmarium lundellii* from Chlorophyta division were found to be rare and low numbers.

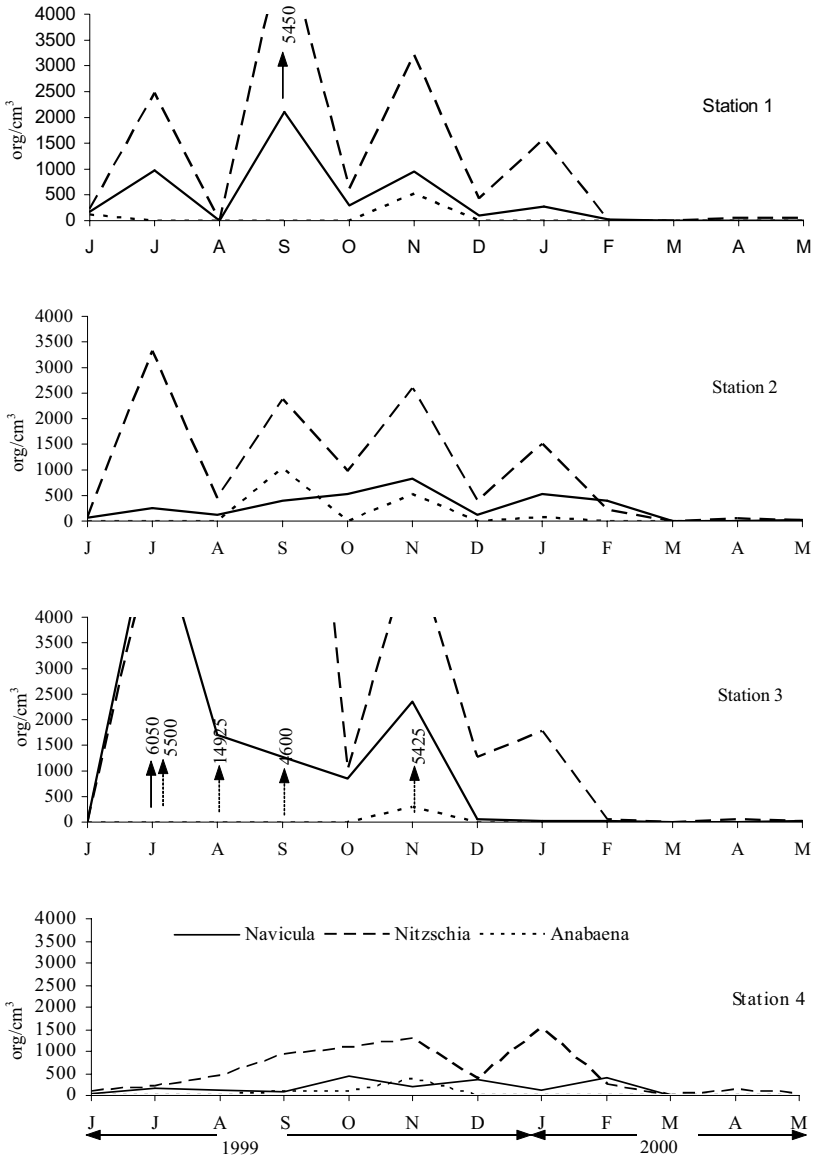


**Fig.4.** The seasonal variations of total *Navicula, Nitzschia* and *Anabaena* spp. in the phytoplankton.

Euglenophyta division includes the species of *Euglena, Phacus* and *Trachelomonas*. Although Euglenales ordo was represented by only one sample in the stream of Meram (Yıldız, 1984), the River of Karasu (Fırat) (Altuner and Gürbüz, 1989) and Yeşilırmak (Tokat) (Pabuçcu and Altuner, 1998), in our study area *Euglena deses* f. *major, E. minuta* and *E. satelles* were recorded. *Euglena deses* f. *major* was more spread and abundant compared to others. Although *Phacus acuminatus* was the only species belong to *Phacus* genus in the River Yeşilırmak (Tokat) (Pabuçcu and Altuner, 1998), *Phacus arnoldii* was recorded as well as *Phacus acuminatus* in our study area.

Almost similiar seasonal variations were observed from the point of view of total organism numbers in St1., St2. and St3. In St4. there was continiual increase untill November in total organism numbers then similiar developments to other stations were observed.

Agreeing with what has already been pointed out by Claps (1996), a reduction in algal population after the spring floods could be seen. Epipelic and planktonic algae flora of the River Yeşilırmak were

affected in the same way by flood in spring. Similiar conditions were also observed in Karasu (Fırat) River (Altuner and Gürbüz, 1990) and Meram Stream (Yıldız, 1985). However, floods affected both community in different ways in the River Pampean in Argentina (Solari and Claps, 1996). The phytoplankton was enriched whereas on the sediments an impoverishment took place. In the phytoplankton the incorporation of species of lentic origin was observed. On the contrary, a reduction in their algal populations on the sediments took place.

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