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Qualitative and Quantitative Changes of Phytoplankton in the South East Black Sea (Trabzon Coasts)

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Abstract

This study was done at three different stations off the coasts of Yomra, Trabzon between September 2007 and August 2008. Nansen bottle of 5 l was used for vertical phytoplankton sampling and standard type plankton net of 29 cm spread and 55 µm mesh size was used for horizontal sampling. 110 species of 6 classes were identified in the qualitative and quantitative samplings of phytoplankton. Bacillariophyceae and Dinophyceae formed the dominant groups in all months and at all stations. In terms of species composition, dinoflagellates were the dominant group with 47,3% and diatoms were the second with 46,4%. In total distribution of phytoplankton abundance, diatoms were found to be 65% and dinoflagellates 32%.

Keywords: Black Sea, phytoplankton, abundance, species composition, annual distribution

Özet

Güneydoğu Karadeniz'de (Trabzon Kıyıları) Fitoplanktonun Kalitatif ve Kantitatif Değişimi

Çalışma, Trabzon-Yomra açıklarında Eylül 2007-Ağustos 2008 tarihleri arasında, üç farklı istasyonda yapılmıştır. Vertikal fitoplankton örneklemelerinde 5lt lik Nansen şişesi, horizontal örneklemelerde ise ağız açıklığı 29 cm olan 55 µm göz açıklığına sahip standart tip plankton kepçesi kullanılmıştır. Fitoplanktonun kalitatif ve kantitatif örneklemelerinden 6 sınıfa ait 110 tür belirlenmiştir. Bacillariophyceae ve Dinophyceae tüm aylarda ve istasyonlarda baskın grupları oluşturmuştur. Tür kompozisyonu bakımından dinoflagellatlar % 47,3'lük oranla dominant grup olurken, diyatomlar %46,4'lük oranla ikinci sırada yer almıştır. Toplam fitoplankton bolluğunun dağılımında ise, diyatomların %64'lük, dinoflagellatların % 32'lük bir paya sahip oldukları tespit edilmiştir.

Anahtar Kelimeler: Karadeniz, fitoplankton, bolluk, tür kompozisyonu, yıllık dağılım

Introduction

With its semi-closed system, the Black Sea is exposed to intensive chemical, organic matter and nutrients from the surrounding countries through main rivers, especially on the west part of it. Even the smallest change in nutrient balance can cause changes first in the phytoplankton and then in the whole ecosystem due to the complex food web.

The Black Sea began to change under various anthropogenic effects in 1960s. Some of these effects are eutrophication, overfishing, the entry of different species and the decrease in freshwater input which creates large scale ecological results (Shiganova and Bulgakova, 2000).

These high levels of chemical changes have affected the phytoplankton structure, composition and distribution through physical process in the Black sea (Eker *et al*., 1999; 2003).

In general, they are the nutrients which increase with nitrogen and phosphorus eutrophication and this increase mostly lead to excessive phytoplankton growth. However, diatoms need silicate as well as these nutrients for their skeletons. Therefore, other phytoplankton groups such as dinoflagellates and coccoliths increase in number and biomass in eutrophic areas.

In connection with this, the results of previous studies showed that diatoms were superior in both qualitative and quantitative ways in the years before eutrophication in the Black Sea, however, recent studies show that dinoflagellates are superior with the increase in eutrophication (Bologa, 1986; Zaitsev and Alexandrov, 1997).

Phytoplanktonic organisms present in all aquatic environments where adequate light is sufficient. They are quite important because they have broad dispersion area, high in number, and also they are main aliment source for other organism in food chain. Almost all the fish with high economic value hatch and start to live as plankton. The survival of larvae consuming food sacs depends on the plankton population (Özel, 1998). In that case, any change in the environment affects not only the plankton but also the fish population. Plankton studies play an important role in determining the optimum fishing quality in fish stocks (Feyzioğlu, 1996; Bat *et al*., 2007).

Necessary precautions are taken against any probable negative ecological developments by observing the regional species diversity and abundance state of plankton and also all the changes in the ecosystem from the past onwards (Eker *et al*., 1999; Taş and Okuş, 2006).

The studies on planktonic organisms are becoming more significant due to the measures mentioned above. Although a considerable number of studies have been conducted on this issue in the North western Black Sea exposed to very rapid changes in recent years (Nesterova, 1986; Bodeanu; 1993; Moncheva *et al*., 1995; Moncheva and Krastev, 1997; Eker *et al*., 1999), there are very few studies about the year round abundance and the seasonal distribution of phytoplankton in the South Eastern Black Sea (Karaçam and Düzgüneş, 1990; Feyzioğlu, 1990; Feyzioğlu and Tuncer, 1994; Feyzioğlu, 1996; Feyzioğlu and Seyhan, 2007).

Aim of the study is to determine and understand the seasonal qualitative and quantitative changes of phytoplankton in Trabzon coast and to form basis for other studies to observe any probable changes.

Materials and Methods

This study was carried out in Trabzon Central Fisheries Research Institute in Yomra Coast between September 2007 and August 2008 on board R/V ARAŞTIRMA 1. Samples were taken from three fix stations from coast to off. The first station was close to the coast with a maximum depth of 50 m, the second station was off the coast with a depth of 100 m, and the third station was further away with a depth of 200 m (Figure 1).

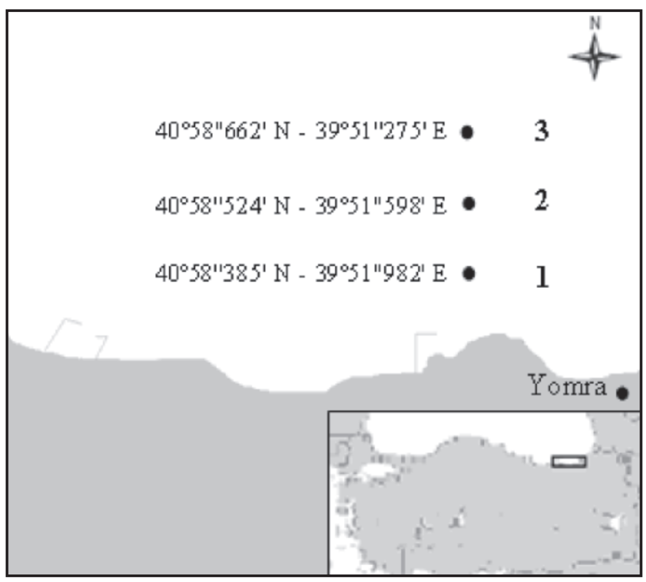

Figure 1. Map of the research area.

Standard type plankton net with 29 cm mouth diameter and 55 µm mesh size and 5 litter capacity Nansen bottle was used for phytoplankton sampling. For Horizontal samplings, 5 minutes of collection was done with plankton net and used for species identification. Samples were collected with the plankton net and fixed with 4% of final immediately after collections.

Water sample taken with Nansen bottle for phytoplankton cell counting were settled in the laboratory and concentrated to final volume of 5-10 ml after fixation with Standard lugol fixative (40 g potassium iodide + 60 g crystallized iodine+ 1 l distilled water). After settlement process, 4% formaldehyde was added to samples and they were kept in a dark place until to count.

Cell- counting was carried out under OLYMPUS BH 2 and Nikon E600 bright field microscopes by using single drop technique. The results were converted to cell/L by back computation (Venrick, 1978; Semina, 1978).

OLYMPUS BH 2 and Nikon E600 bright field, fluorescent and phase contrast microscopes were used for species identification. Species identifications were done according to Trego-uboff and Rose (1957), Lindley (1992), Tomas (1993a), Tomas (1993b), Fukuyo (1999), Newell (2001), Koray (2002), Vershinin (2005), Kraberg and Montagnes (2006) and Cooper and Dolan (2006).

Results

Phytoplankton Taxons

In the examination of lift-net and bottle samples during the study, 110 species were identified belonging to Bacillariophyceae (51), Dinophyceae (52), Dictyochophyceae (3), Chrysophyceae (1), Euglenophyceae (2) and Prymnesiophyceae (1) (Table 1).

Distribution of Phytoplankton Abundance

There was a statistically difference between the monthly distributions of the abundance in phytoplankton groups ($P < 0.05$). Bacillari-ophyceae had the highest cell density in October (113186±9066 cells/L) and the lowest in July (6813±982 cells/L).

The average density of Bacillariophyceae was 40936±7533 cells/L. The most dominant group in Phytoplankton in all months but May and July, Bacillariophyceae had three peak points in October, March and June (Table 2).

Dinophyceae had the highest cell density of 61668±3810 cells/L (May), the lowest 3723±343 cells/L (December) and average 20240±2808 cells/L. Dinophyceae was the most dominant group in May and July, and made one peak in May.

Dictyochophyceae had the highest cell density of 2227±445 cells/L (January), the lowest 0 (October, May, July, August and October) and average 403±92 cells/L. Other phytoplanktons had the highest cell density of 6444±1991 cells/L (June), the lowest 46±15 cells/L (September) and average 1198±265 cells/L.

In general, Bacillariophyceae and Dinophy-ceae classis were dominant in all months but other groups did not show any important assets. In the annual growth chart of Phytoplankton, it was shown that there were two peak points, the first and the bigger in October (123304 cells/L), and the second and the smaller in March (111745 cells/L).

Total phytoplankton density was low in two periods. The first and the lowest was between November and February (winter seanson), and

Table 1. Phytoplankton species identified between September 2007 and August 2008

BACILLARIOPHYCEAE	51
Achnanthes taeniata (Cleve) Grunow	
Achnanthes sp.	
Actinoptychus senarius Ehrenberg	
Biddulphia sp.	
Ceratualina pelagica (Cleve) Hendey	
Chaetoceros aequatorialis Cleve	
Chaetoceros affinis Lauder	
Chaetoceros brevis (Schütt)	
Chaetoceros compressus Lauder	
Chaetoceros curvisetus Cleve	
Chaetoceros decipiens Cleve	
Chaetoceros diedema (Ehrenberg) Gran	
Chaetoceros lorenzianus Grunow	
Chaetoceros tortissimus Gran	
Chaetoceros wighamii Brightwell	
Climacosphenia moniligera Ehrenberg	
Coscinodiscus granii Gough	
Coscinodiscus radiatus Ehrenberg	
Coscinodiscus wailesii Gran et Angst	
Coscinodiscus sp.	
Diatoma sp.	
Ditylum brightwellii (T.West) Grunow	
Eucampia sp.	
Grammatophora marina (Lyngb.) Kütz.	
Guinardia flaccida (Castrac.) H.Perag.	
Hemiaulus sinensis Greville	
Leptocylindrus danicus Cleve	
Licmophora sp.	
Melosira sp.	
Navicula sp.	
Nitzschia closterium (Ehrenberg) W.Smith.	
Nitzschia longissima (Breb.) Ralfs	
Pleurosigma sp.	
Pseudonitzschia seriata (Cleve) Peragallo	
Pseudonitzschia pungens (Grunow ex Cleve) Hasle	
Pseudonitzschia delicatissima (Cleve) Heiden	
Pterosperma sp.	
Rhizosolenia alata Brightwell.	
Rhizosolenia calcar-avis M.Schultze	
Rhizosolenia fragilissima Bergon	
Rhizosolenia setigera Brightwell	
Skeletonema costatum (Grev.) Cleve	
Striatella delicatula (Kütz) Grun	
Synedra sp.	
Thalassionema nitzschioides Hust.	
Thalassiosira angustelineata (G.W.Schmidt) G.A.Fryxe & Halse	
Thalassiosira nordenskioeldii Cleve	
Thalassiosira punctigera Castracane	
Thalassiosira weissflogii Grunow	
Thalassiosira sp.	

Triceratium favus Ehrenberg	
DINOPHYCEAE	52
Alexandrium tamarense (Lebour) Balech	
Alexandrium sp.	
Ceratium fusus (Ehrenberg) Dujardin	
Ceratium furca (Ehrenberg)	
Ceratium horridum (Cleve) Gran	
Ceratium lineatum (Ehrenberg) Cleve	
Ceratium tripos (O.F. Müler) Nitzsch	
Dinophysis acuminata Clap.&J.Lachm.	
Dinophysis acuta Ehrenberg	
Dinophysis caudata Kent	
Dinophysis hastata F.R.Stein	
Dinophysis rotundata Clap.&J.Lachm.	
Diplopsalis lenticula Bergh	
Exuviella compressa (Bailey) Ostenfeld	
Glenodinium lenticula (Bergh) Schiller	
Gonyaulax digitalis (Pouchet) Kofoid	
Gonyaulax polyedra F.Stein	
Gonyaulax spinifera (Clap.&J.Lachm.) Diesing	
Gonyaulax sp.	
Gymnodinium sanguineum Hirasaka	
Gymnodinium sp.	
Gyrodinium sp.	
Heterocapsa triquetra (Ehrenberg) Balech	
Lingulodinium polyedrum (Stein) Dodge	
Noctiluca scintillans (Macartney) Kof.&Swezy	
Oxyphysis oxytoxoides Kofoid	
Phalacroma rotundatum (Clap. et Lachmann) Kofoid et Michener	
Prorocentrum balticum (Lohmann) A.R.Loebl	
Prorocentrum compressum (Bailey) T.H.Abe.	
Prorocentrum lima (Ehrenberg) Dodge	
Prorocentrum micans Ehrenb.	
Prorocentrum minimum J. Schiller	
Protoceratium reticulatum Bütschli	
Protoperidinium claudicans Paulsen	
Protoperidinium conicoides Paulsen	
Protoperidinium conicum (Gran) Balech	
Protoperidinium curtipes Jurgensen	
Protoperidinium depressum (Bailey) Balech	
Protoperidinium divergens (Ehrenb.) Balech	
Protoperidinium granii (Ostenf) Balech	
Protoperidinium leonis (Pavillard) Balech	
Protoperidinium pallidum (Ostenf) Balech	
Protoperidinium pellucidum (Berg) Balech	
Protoperidinium pentagonum Gran	
Protoperidinium punctulatum (Paulsen) Balech	
Protoperidinium steinii (C.Jorg) Balech	
Protoperidinium subinerme Paulsen Balech	
Protoperidinium thorianum (Paulsen) Balech	
Pyrocystis sp.	
Pyrophacus sp.	

Scrippsiella sp.	
Scrippsiella trochoidea (Stein)	
DICTYOCHOPHYCEAE	3
Dictyocha fibula Ehrenberg	
Dictyocha speculum Ehrenberg	
Octactis octonaria (Ehrenberg) Hovasse	
EUGLENOPHYCEAE	2
Euglena acusformis Schiller	
Eutreptia lanowi Steuer	
PRYMNESIOPHYCEAE	1
Phaeocystis globosa Scherffel	
CHRYSOPHYCEAE	1
Dinobryon faculiferun Willen	
TOTAL	**110**

Table 2. Abundance distribution (cells/L) of phytoplankton groups by months (mean ± SE)(average abundance of the 3 stations)

	Bacillariophyceae	Dinophyceae	Dictyochophyceae	Others	Total
Sep.07	61523±27721[a]	7293±1675[a]	359±195[a]	15±15 [a]	69191±29345[a]
Oct.07	113186±9066[b]	10068±662[a]	*	50±30 [a]	**123304±29074[b]**
Nov.07	14234±5653[c]	14023±603[a]	24±13[a]	304±117 [a]	28585±4863[ac]
Dec.07	17773±9914[c]	3723±343[a]	193±61[a]	279±77 [a]	21967±6079[ac]
Jan.08	15081±1770[c]	7548±1684[a]	2227±445[b]	84±53 [a]	24940±3650[ac]
Feb.08	15947±2430[c]	16639±2256[a]	1774±144[b]	73±28 [a]	34434±4867[ac]
Mar.08	95836±24570[ba]	15098±5524[a]	39±23[a]	771±373[a]	**111745±26242[b]**
Apr.08	49139±3747[ac]	40843±13085a[b]	215±214[a]	284±69[a]	90481±14807[ab]
May.08	34593±501[ac]	61668±3810[c]	*	3082±76[b]	99343±15307[ab]
Jun.08	50242±3526[ac]	36986±2322[b]	9±9[a]	6444±1991 [c]	93681±12747[ab]
Jul.08	6813±982[c]	12320±1267[a]	*	1360±234[ab]	20493±3023[c]
Aug.08	16861±512[c]	16671±467[a]	*	1629±111[ab]	35161±4837[ca]
Mean	40936±7533	20240±2808	403±92	1198±265	62777±5037

•*Not found in the census,* Different letters in the same column represent the difference among months (P < 0.05)

Table 3. Abundance (cells/L) distribution of phytoplankton groups to stations (mean. ± SE)

	Bacillariophyceae	Dinophyceae	Dictyochophyceae	Others	Total
1. Station	34744±6896[a]	17941±4607[a]	470±271[a]	1447±855[a]	54602±8731[a]
2. Station	39943±10854[a]	20342±5222[a]	422±225[a]	1079±394[a]	61785±12723[a]
3. Station	48120±14120[a]	22437±5999[a]	319±183[a]	1068±435[a]	71944±15164[a]
Mean	40936±10623	20240±5276	403±227	1198±561	**62777±5037**

Different letters in the same column represent the difference among stations (P<0.05)

and the second was between July and August (Figure 2). The distribution of phytoplankton groups to stations is given in Table 3. The difference in the distribution of all phytoplankton groups to the stations was not statistically significant (P>0.05).

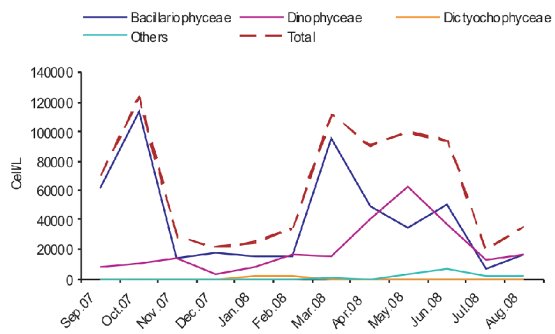

Figure 2. Phytoplankton Abundance Distribution By Months.

Bacillariophyceae and Dinophyceae were found to be the most dominant species at all stations. Other phytoplankton groups had similar distributions among stations (Figure 3).

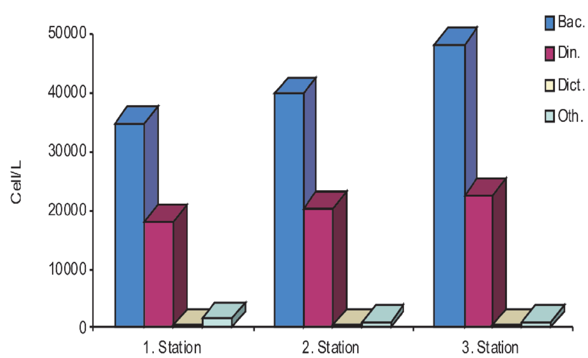

Figure 3. Annual average distributions of phytoplankton groups to the stations (cells/L).

When the proportional distribution of phytoplankton density was considered, Bacillariophyceae and Dinophyceae were found to be the most dominant two groups in all months. Other phytoplankton groups had similar distributions among stations. Phytoplankton had 33 % - 92% of Bacillaryophyceae and 8% - 62% of Dinophyceae (Figure 4).

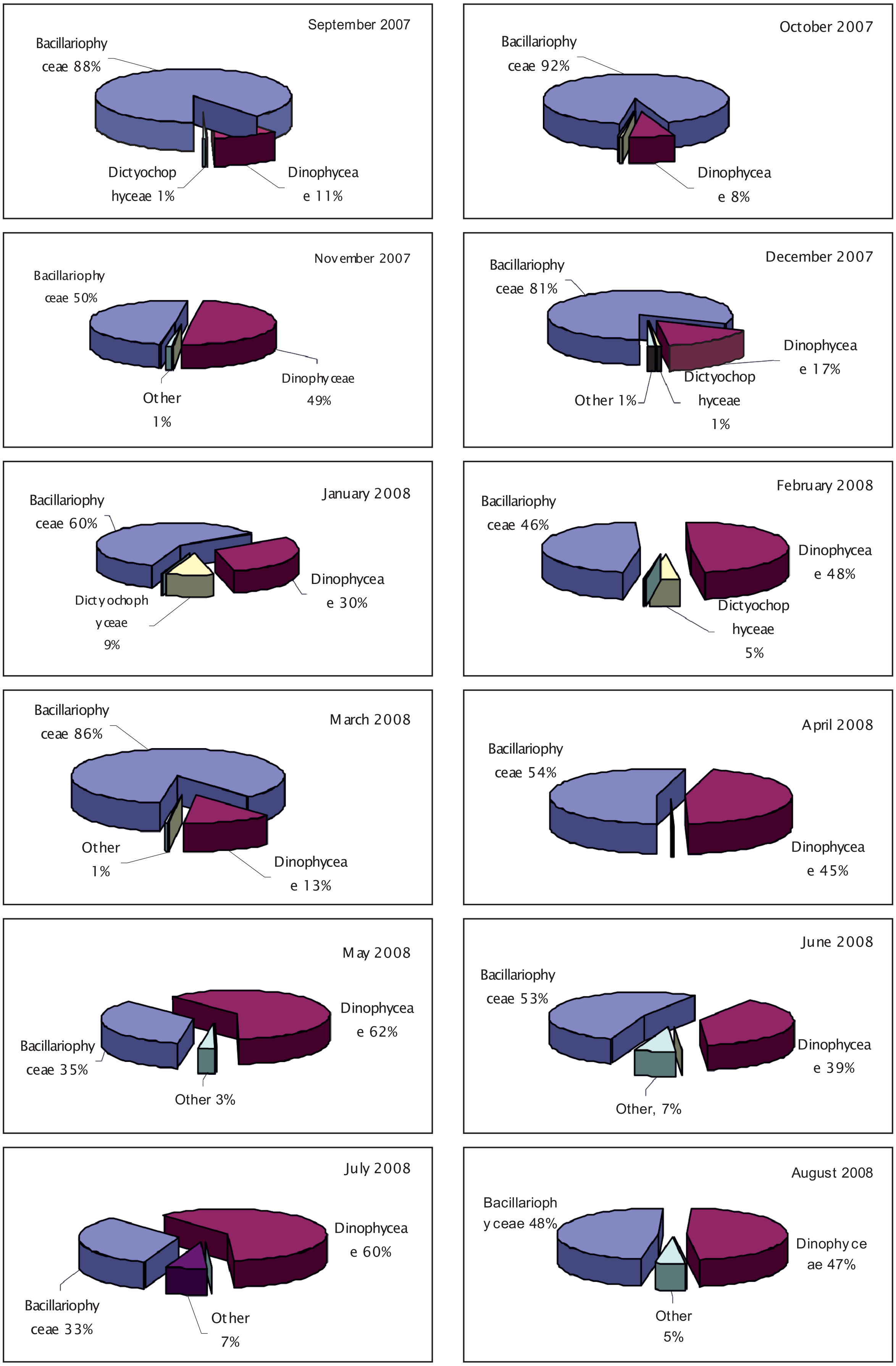

Figure 4. Proportional density distribution of phytoplankton groups by months (%)

Discussion

In the study done between September 2007 and August 2008 at three stations, 51 Bacillariophyceae, 52 Dinophyceae, 3 Dictyochophyceae, 1 Chrysophyceae, 2 Euglenophyceae and 1 Prymnesiophyceae, 110 phytoplankton species in total were identified. In terms of species composition, dinoflagellates were the dominant group with 47,3% and diatoms were the second with 46,4%.

All phytoplankton species commonly found over the study period were *Chaetoceros* spp., *Pseudonitzschia* spp. and *Rhizosolenia* spp. of diatoms; and *Ceratium* spp., *Prorocentrum* spp. and *Protoperidinium* spp. of Dinoflagellates.

When the phytoplankton gathered in the present study was compared with other studies done in the Black Sea, a high degree of qualitative similarity was realized. In this study as in others, Bacillariophyceae and Dinophyceae were more common in terms of species number, and the sequence of other algal groups showed seasonal changes. Bacillariophyceae is of great importance in terms of species diversity and biomass in marine ecosystems. The number of phytoplankton species identified in the Black Sea by different researchers is shown in Table 4.

In the previous studies of Southeast Black Sea, Karacam and Düzgünes (1990) identified 17 diatoms and 12 dinoflagellates in surface sea water between November 1987 and October 1988. Feyzioğlu (1990) reported 62 diatom and 36 dinoflagellates species between March 1989 and February 1990. Similarly, Feyzioğlu (1996) identified 102 phytoplankton species in his study, 56 of which were diatoms and 35 of which were dinoflagellates.

In their studies comparing present phytoplankton composition between 1993 and 1994 and 2001 and 2002 sampling periods in the Southeast Black Sea, Feyzioğlu and Seyhan (2007) identified 115 species of 5 classes in total in the sampling area. They reported Diatoms and Dinoflagellates to be the dominant phytoplankton groups in both sampling periods. However, dinoflagellates proportion increased from 35 % to 41 % in the sampling period of 20012002.

Bat *et al*. (2007) reported that the decrease in the role of diatoms on phytoplankton community bloom as well as the increase in the roles of dinoflagellates, euglenoid and coccolithoforids is due to the accumulation of nutrients and anthropogenic items through the rivers flowing into the Black Sea over the last twenty-five years. From the studies done it is clear that the number of dinoflagellate species were fewer than that of diatoms in previous years. However, with the increase in eutrophication in recent years there has been an increase in the number and abundance ratios of dinoflagellates among all species.

Zaitsev and Aleksandrov (1997) informed that diatoms were superior in both qualitative and quantitative ways in the previous results, yet dinoflagellates are superior in current studies.

Bat *et al*. (2007) informed that it is inevitable for phytoplankton organisms to be affected by probable small changes in physical and chemical oceanography as they are small and react rapidly to environmental conditions. They indicated that changing environmental conditions correspond to the qualitative and quantitative differences in phytoplanktonic structure. Therefore, the identification of indicator species in any phytoplanktonic structure in a certain region will make it easier to understand the changes in ecosystem, and continuous studies will result in more accurate and effective interpretations.

Although intensive algal growth was observed at the third station from time to time which was further offshore than the other stations. The distribution of phytoplakton abundance between stations was not statistically significant ($P > 0.05$).

Phytoplakton groups in order of dominance at all stations are Bacillariophyceae > Dinophyceae > Dictyochophyceae > Others. In accordance with the distribution at the stations, general distribution of the total density of phytoplankton follows the same order. (65% of Bacillariophyceae, 32% of Dinophyceae, 3% of Dictyochophyceae and other groups). Although this order changes depending on the properties of aquatic environments, it is similar to other studies done at the Black Sea.

When monthly development of phytoplankton groups were examined, Bacillariophyceae was dominant in September, October, November, December, January, March, April, June and August; and Dinophyceae was dominant in February, May and July.

In general, the majority of peak points were in the days following the winter season when nutrient salt deposition occurred in aquatic ecosystems. Starting with the spring warming of surface waters, vertical mixing distributes both nutrient salts and microalgae cysts of the previous year in a body of water. The prolonged period of light due to open-air conditions in the days following and temperature increase provides intensive reproduction (Koray, 2002).

Sorokin (1983) pointed out that algal reproduction in the Black Sea as in other temperate regions creates two peaks in a year and the bigger of these is in the late winter and early spring, and the second and the smaller is in the late summer and early autumn.

In this study, there are two peak points, the first and bigger in October (123304±29074 cells/L), the second and the smaller in March (111745±26242 cells/L). Bacillariophyceae had important contributions to both of these increases. Contrary to Sorokin (1983) and Koray (2002), the bigger peak point was determined in October (autumn) in this study.

Seasonal qualitative and quantitative development of phytoplankton has shown differences by months ($P < 0.05$). The average density of phytoplankton in September 2007 and August 2008 period was 62777±5037 cells/L. The most intense phytoplankton was found in October (123304±9706 cells/L). The dominant group in this month was Bacillariophyceae. The comparison of studies in terms of abundance conducted by different researchers at the Southeast Black Sea is given in Table 5.

Eker *et al*. (1999) informed that phytoplankton cell density was 98228 cells/L and 86607 cells/L in March-April 1995 and October 1995, respectively, in the Southeast Black Sea. Uysal *et al*. (1997) reported it to be 347366 cells/L in July 1996. Feyzioğlu (1996) stated that phytoplankton density rose to 10^6 cells/L in 1993-1994, and it was 10^4-10^5 cells/L in other periods. Uysal (2002) reported that phytoplankton species composition, growth and distribution are controlled by such environmental factors as time-dependent changes of temperature, salinity, density, light intensity and nutrient supply.

In comparison, our results are similar to that of other studies carried out in the Southern Black Sea.

In this study, monthly distribution of phytoplankton abundance in the southern Black Sea (Trabzon coast) and group composition were investigated in there stations and compared to previous data from the same region. In this regard, the present study could give a basis for future studies in this region.

Acknowledgements

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Table 4. The number of phytoplankton species identified in the Black Sea by different researchers

Reference	Region	Period	Total number of species
Karaçam and Düzgüneş (1990)	Southeast Black Sea	November 1987- October 1988	29
Feyzioğlu (1990)	Southeast Black Sea	March 1989-February 1990	104
Feyzioğlu and Tuncer (1994)	Southeast Black Sea	1988–1989	97
Feyzioğlu (1996)	Southeast Black Sea	January 1993– August 1994	102
Feyzioğlu and Seyhan (2007)	South Black Sea	2001–2002	68
Uysal (1993)	South Black Sea	April 1989	92
Uysal (1993)	South Black Sea	February 1990	122
Uysal (1993)	South Black Sea	April 1990	56
Eker et al (1999)	South Black Sea	October 1995	108
Türkoğlu and Koray (2002)	South Black Sea	August 1995- July 1996	178
Bat et al. (2005)	South Black Sea	January 2002-December 2003	110
Bat et al. (2007)	South Black Sea	2002	107
Bat et al. (2007)	South Black Sea	2003	94
Şahin et al. (2007)	South Black Sea	January -May 1999	129
Şahin et al. (2007)	South Black Sea	March-October 2000	70
Bayraktar (1994)	Whole Black Sea	July 1992	118
Eker et al. (1999)	Whole Black Sea	March- April 1995	142
Taş and Okuş (2006)	Whole Black Sea	September 2004	73
Taş and Okuş (2006)	Whole Black Sea	April 2005	57
Taş and Okuş (2006)	Whole Black Sea	October 2005	68
This research	Southeast Black Sea	September 2007- August 2008	**110**

Table 5. The comparison of studies in terms of abundance conducted by different researchers at the Southeast Black Sea (cells/L)

Reference	Region	Period	Abundance (cell/L)
Eker et al. (1999)	Southeast Black Sea	March - April 1995	98228
Eker et al. (1999)	Southeast Black Sea	October 1995	86607
Uysal et al. (1997)	Southeast Black Sea	July 1996	347366
Uysal (1993)	Southeast Black Sea	April 1989	141
Uysal, (1993)	Southeast Black Sea	February 1990 (>55µ)	22969
Bayraktar (1994)	Southeast Black Sea	July 1992(>55µ)	470272
Feyzioğlu (1996)	Southeast Black Sea	June 93- Aug. 94 (winter)	$<1*10^5$
Feyzioğlu (1996)	Southeast Black Sea	Jun. 93- Aug. 94 (spring)	$>1*10^5$
This research	Southeast Black Sea	September 2007	69191
		October 2007	123304
		November 2007	28585
		December 2007	21967
		January 2008	24940
		February 2008	34434
		March 2008	111745
		April 2008	90481
		May 2008	99343
		June 2008	93681
		July 2008	20493
		August 2008	35161
		Mean	**62777±5037**

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