J. Black Sea/Mediterranean Environment
Vol 13: 7-17(2007)

Diatom increase in phytoplankton community observed in winter in the north-eastern Marmara Sea (Beylikdüzü)

Kuzeydoğu Marmara Denizi'nde (Beylikdüzü) kış mevsiminde fitoplankton kommunitesinde gözlenen diyatom artışı

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Abstract

In this study, a diatom increase in the phytoplankton community in the north-east part of Sea of Marmara was observed in winter (upper layer water temperature between 7-9°C and salinity between 22-24 psu). In the water samples were determined a total of 45 phytoplankton taxa from the four algae classes. Most of these taxa (94 %) were composed of dinoflagellates and diatoms and other organisms parts were silicoflagellates and euglenoid flagellate species. The most common species from diatoms were *Proboscia alata* f. a*lata* (Brightwell) Sundström, from dinoflagellates *Ceratium fusus* (Ehrenberg) Dujardin. The diatom *Proboscia alata* f. *alata* was quantitatively the dominant species in the phytoplankton community. The highest cell density was measured about 185 x 10^3 cells l^{-1}. It is noticeable that diatoms were more dominant than other phytoplankton species.

Key Words: Phytoplankton, diatom, *Proboscia alata*, north-eastern Marmara Sea

Introduction

Büyükçekmece Bay is a part of the Sea of Marmara, which is located between the continents of Asia and Europe. The Sea of Marmara has a strong halocline that separates the low saline water originating from the

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Black Sea and the high saline water originating from the Mediterranean Sea (Beşiktepe *et al.,* 1995). The study area is located at the east of Büyükçekmece Bay (north-eastern Sea of Marmara) (lat. 40^o.95' N, long. 28^o 62'-28^o 64' E), where it is known as Beylikdüzü. In this study area there is a severely polluted stream (Kavaklıdere) (Figure 1). Phytoplankters are the basic food in the sea for all consumers such as zooplankton and fish. In the recent years, applied aspects of phytoplankton research have become more and more important (Zeitzschel, 1978). The more obvious representatives of phytoplankton in the sea will be diatoms and dinoflagellates. The diatoms have cell walls of silica (SiO_2) with complex surface patterning. The shapes of diatom cells can be complex, and are important in determining genera and species (Boney, 1989).

The main goal of this study is the assessment of an increase in diatom abundance that occurred in winter in the north-eastern Marmara Sea.

Material and Methods

In this study, the phytoplankton sampling was carried out at 5 stations on 2 February 2006 (Figure 1). Water samples collected from standard depths (0.5, 5, 10, 20) by Niskin bottles were transferred into 1 liter PVC containers. These samples were preserved with borax buffered formaldehyde solution (final concentration 0.4%) (Throndsen, 1978).The fixed samples were left for a week for sedimentation in the laboratory similarly to Utermohl method (Utermöhl, 1958) and then the supernatant was removed by siphoning and the precipitated part was transferred to 100 ml dark glass bottles (Sukhanova, 1978). The phytoplankton cells were counted with a Sedgwick-Rafter counting cell under a light microscope with x100 magnification (Guillard, 1978).

For the qualitative analysis of phytoplankton, net samples were taken vertically by a standard Nansen plankton net, diameter 57 cm, pore size 55 µm. Then the net phytoplankton samples were transferred into plastic vessel (330 cc) and fixed with 40 % buffered borax formaldehyde solution (final concentration 4 %) (Throndsen, 1978).

For species identifications one or two drop of net samples were placed on the glass slide and covered with a cover glass and then species were identified under a light microscope with x100, x200 or x400 magnifications. The following references were used for species identification; Cupp (1943), Delgado and Fortuna, (1991), Dodge, (1985), Drebes (1974), Hasle *et al*., (1997), Hendey (1964), Ricard and Dorst (1987). The species diversity was calculated by Shannon-Wiener (H') (Zar, 1984) and Pielou Evenness indices (J) (Pielou, 1975).

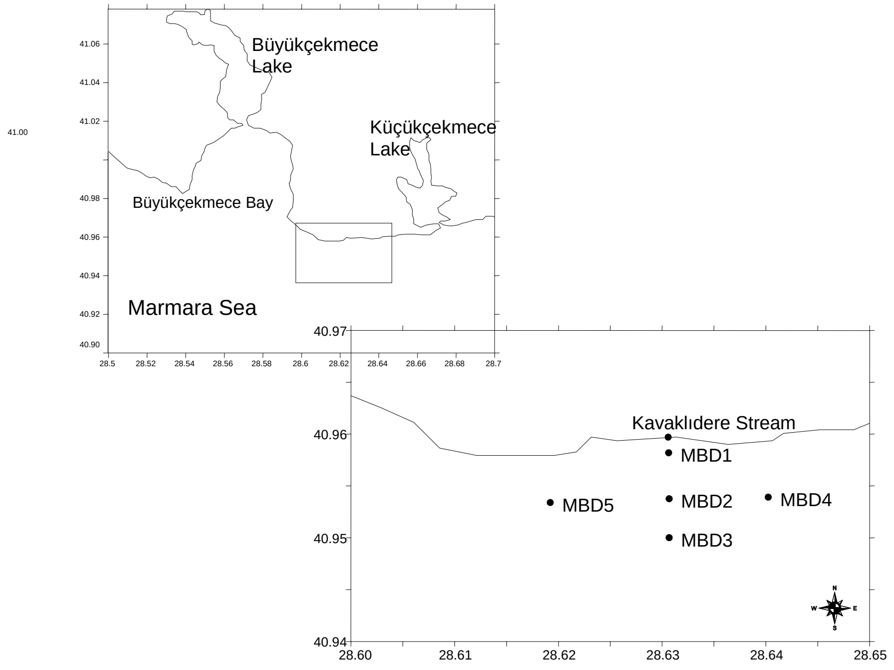

Figure 1. Location of the study area and sampling stations

Results

In the study area, the upper layer (0-20 m) water temperature was measured between 7-9°C and salinity was measured between 22-24 psu. The nutrient concentrations decreased in sampling points, while the concentrations at the stream mouth were fairly high (total phosphorus 12.82 µM, total nitrogen 18.18 µM). Silicate has a high concentration (46 µM) at the stream output, that displayed variability depending on the diatoms density. Especially in depths of 5 and 10 meters the silicate concentrations declined parallel to increasing diatom density. Temperature may have indirect effects upon diatom communities. For instance, increased temperature decreases the viscosity of the water and thus increases the sinking rate of planktonic diatoms. It is well known that diatoms living in warm water often have less silica in their cell walls than those living in cold water (Hay *et al*., 1990)

Chlorophyll *a* values at the upper layer ranged between 5-28 µg l^{-1} and clearly indicates phytoplankton abundance. In this study a total of 45 phytoplankton taxa were determined from the four algae classes. These taxa were represented as a species list in Table 1. The identified phytoplankton species in this study are present in the phytoplankton list of the Sea of Marmara (Balkıs, 2004). Diatoms (22 taxa) and dinoflagellates (20 taxa) were more abundant (94 %) than the other taxonomic groups. However, diatoms were more abundant quantitatively than dinoflagellates. The quantitative proportion of diatoms (91.1 %) in the total community was fairly higher than the dinoflagellates (5.76 %). The silicoflagellates (Dictyochophyceae) and euglenoid flagellates (Euglenophyceae) were the other taxonomic groups. The most common taxa in terms of abundance from dinoflagellates were *Ceratium fusus* (Ehrenberg) Dujardin, *Prorocentrum* spp., and *Scrippsiella trochoidea* (Stein) Loeblich III, from diatoms *Chaetoceros* spp., *Ditylum brightwelli* (T. West) Grunow in Van Heurck, *Proboscia alata* f. *alata* (Brightwell) Sundström. A diatom species P. *alata* f. *alata* was the dominant species in the phytoplankton community in all the water samples.

In the study area, which is a coastal area and a polluted stream input, the phytoplankton community reached high density. The highest phytoplankton density (185 x 10^3 cell l^{-1}) was found in a depth of 10 meters at the station MBD2. In the phytoplankton density it is observed that it increased more in depths of 5 and 10 meters compared to the surface water (Figure 2). It was clear that diatoms were dominant in terms of cell number. Diatoms reached max. 177 x 10^3 cells l^{-1}, while dinoflagellates reached max. 13 x 10^3 cells l^{-1} in terms of abundance. The dominant diatom species *P. alata* f. *alata* reached about 110 x 10^3 cells l^{-1} in depth of 10 meter at the station MBD3. In general the species diversity index are parallel to species number and there is a direct proportion between the two values. Shannon-Wiener diversity (H') in all the water samples were calculated between 0.23-2.83, Pielou evenness indices (J) fluctuated between 0.14-0.67. The highest values for diversity (H'= 2.83; J= 0.67) were found in surface water at the station MBD2, where there was also the highest number of species (19 species). When one species was dominant, the diversity values decreased to a minimum. The lowest diversity indices (H'=0.23, J= 0.14) were calculated in depth of 20 meter at the station MBD5, where the diatom *P. alata* f *alata* was dominant in proportion 97 % (Figure 3).

Table 1. List of phytoplankton species identified in the study area

CHROMOPHYTA
Classis: Dinophyceae
Ceratium cf. d*ens* Ostenfeld & Schmidt
Ceratium furca (Ehrenberg) Claparedé & Lachmann
Ceratium fusus (Ehrenberg) Dujardin
Ceratium tripos (O.F. Müller) Nitzsch
Dinophysis acuta Ehrenberg
Diplopsalis lenticula Bergh
Gyrodinium sp.
Heterocapsa triquetra (Ehrenberg) Stein
Noctiluca scintillans (Macartney) Kofoid
Prorocentrum compressum (Bailey) Abé
Prorocentrum micans Ehrenberg
Prorocentrum scutellum Schiller
Prorocentrum triestinum Schiller
Protoperidinium brevipes (Paulsen) Balech
Protoperidinium claudicans (Paulsen) Balech
Protoperidinium conicum (Gran) Balech
Protoperidinium divergens (Ehrenberg) Balech
Protoperidinium sp.
Protoperidinium steinii (Jörgensen) Balech
Scrippsiella trochoidea (Stein) Loeblich III
Classis: Dictyochophyceae
Dictyocha speculum Ehrenberg
Dictyocha fibula Ehrenberg
Classis: Bacillariophyceae
Chaetoceros affinis Lauder
Chaetoceros costatus Pavillard
Chaetoceros curvisetus Cleve
Chaetoceros debilis Cleve
Chaetoceros decipiens Cleve
Chaetoceros didymus Ehrenberg
Chaetoceros holsaticus Schütt
Chaetoceros socialis Lauder
Chaetoceros sp.
Coscinodiscus sp.
Cylindrotheca closterium (Ehrenberg) Reimann & Lewin
Ditylum brightwelli (T. West) Grunow in Van Heurck

Table 1. Contunied

Guinardia delicatula Cleve
Leptocylindrus minimus Gran
Probocia alata f. a*lata* (Brightwell) Sundström
Pseudo-nitzschia sp.
Rhizosolenia setigera Brightwell
Skeletonema costatum (Greville) Cleve
Thalassionema nitzschioides (Grunow) Mereschkowsky
Thalassiosira anguste-lineata (A. Schmit) G. Fryxell & Hasle
Thalassiosira eccentrica (Ehrenberg) Cleve
Thalassiosira rotula Meunier

CHLOROPHYTA
Classis: Euglenophyceae
Eutreptiella sp.

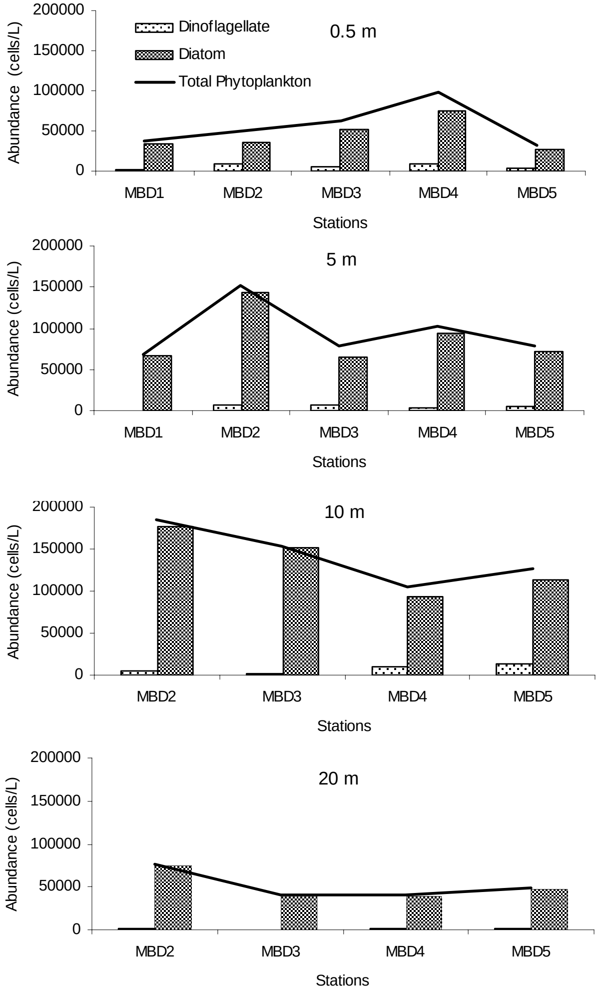

Figure 2. The phytoplankton abundance in the different stations at various depths.

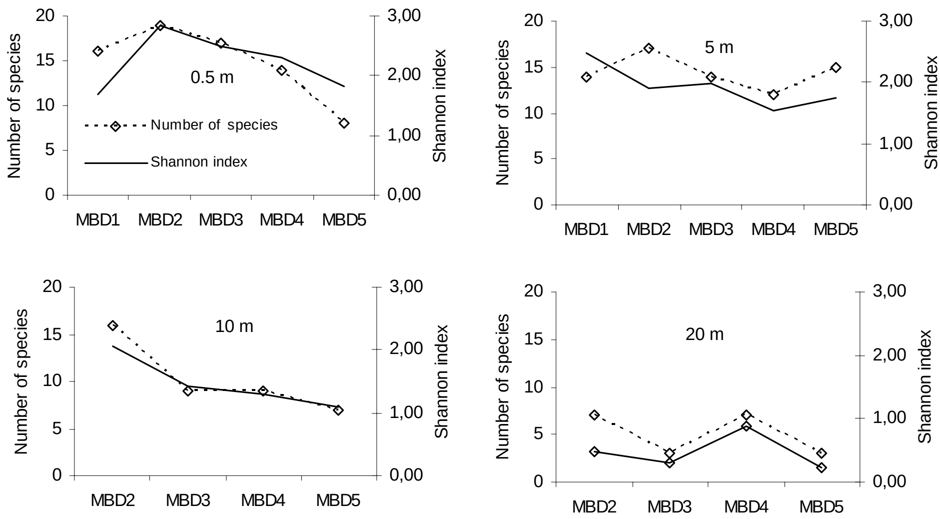

Figure 3. The spatial distributions of the number of species and diversity index

Discussion

In this study, the phytoplankton community structure was determined in the north-eastern Marmara Sea in February. In this research period water temperature in the upper layer fluctuated between 7-9^{o}C, diatoms were observed as the dominant group. In the previous research study in the same area stated, the diatoms reached the highest density in March and it was also reported that the largest part of phytoplankton community (92 %) is constituted of diatoms and dinoflagellates and that diatoms dominated in winter and early spring (Balkıs, 2003). It is reported by Türkoğlu and Koray (2002) that in terms of species number the diatoms were more abundant in winter (January and February) and early spring (March) than in other periods.

The results of the study carried out by Balkıs (2003), in Büyükçekmece Bay do not imply eutrophication; therefore, the upper layer of the Sea of Marmara is considered as oligotrophic (Balkıs, 2003). This study area has been affected by large amounts of domestic and industrial discharges due to heavy pollutant carried by Kavaklıdere Stream and rapidly expanding urban development. This situation caused the increase on the inorganic nutrients concentrations (mainly nitrogen and phosphorus) in the marine environment. This can cause a rapid increase in the phytoplankton cell numbers under the suitable conditions. Large amounts of silicate concentrations are needed by diatom cells and can grow when the silicate concentration increased. Eutrophic conditions may be happening in the phytoplankton bloom and this situation can cause a negative influence for marine ecosystem.

As a result control of coastal discharges must be provided to improve water quality and protect marine ecosystem.

Özet

Bu çalışmada kuzeydoğu Marmara Denizi fitoplankton kommunitesinde kış mevsiminde (üst tabaka su sıcaklığı 7-9^{o}C, tuzluluk 22-24 psu arasında) gözlenen bir diyatom artışı açıklanmaktadır. Bu amaçla örnekleme alanından alınan tüm örneklerde dört alg sınıfından toplam 49 phytoplankton taksonu belirlenmiştir. Bu taksonların büyük çoğunluğunu (%94) dinoflagellat ve diyatomlar oluştururken diğerleri ise silikoflagellat ve öglenoid flagellat türlerinden oluşmaktadır. En sık rastlanan türler diyatomlardan *Proboscia alata* f. a*lata* (Brightwell) Sundström, dinoflagellatlardan *Ceratium fusus* (Ehrenberg) Dujardin türleridir. Tüm çalışma alanında kantitatif olarak *Proboscia alata* f. a*lata* dominant türdür. En yüksek hücre sayısı 185 x 10^3 hücre l^{-1} olarak hesaplanmıştır.. Diyatomların diğer fitoplankton türlerine göre baskın grubu oluşturdukları gözlenmiştir.

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Received: 17.01.2007
Accepted: 26.01.2007