

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

Erdoğan Okuş and Seyfettin Taş*

Istanbul University, Institute of Marine Sciences and Management, Muskule Sok.
No.1, Vefa 34470 Istanbul/TURKEY

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. *alata* (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 185×10^3 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

* Corresponding author: stas@istanbul.edu.tr

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° 95' N, long. 28° 62'-28° 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 (SiO₂) 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%) (Thronsen, 1978). The fixed samples were left for a week for sedimentation in the laboratory similarly to Utermohl method (Utermohl, 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 %) (Thronsen, 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), Hendeý (1964), Ricard and Dorst (1987). The species diversity was calculated by Shannon-Wiener (H') (Zar, 1984) and Pielou Evenness indices (J) (Pielou, 1975).

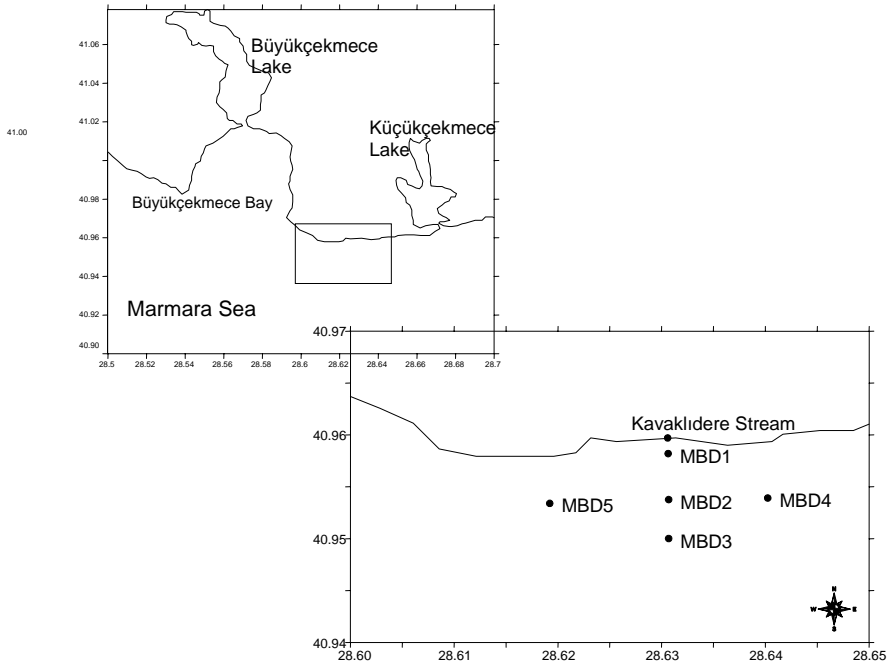


Figure 1. Location of the study area and sampling stations

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 $\mu\text{g l}^{-1}$ 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 (Balkis, 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 ($185 \times 10^3 \text{ cell l}^{-1}$) 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. $177 \times 10^3 \text{ cells l}^{-1}$, while dinoflagellates reached max. $13 \times 10^3 \text{ cells l}^{-1}$ in terms of abundance. The dominant diatom species *P. alata* f. *alata* reached about $110 \times 10^3 \text{ cells l}^{-1}$ 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. *dens* 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 (Jørgensen) Balech

Scrippsiella trochoidea (Stein) Loeblich III

Classis: Dictyochoephyceae

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. Continued

Guinardia delicatula Cleve

Leptocylindrus minimus Gran

Probocia alata f. *alata* (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.

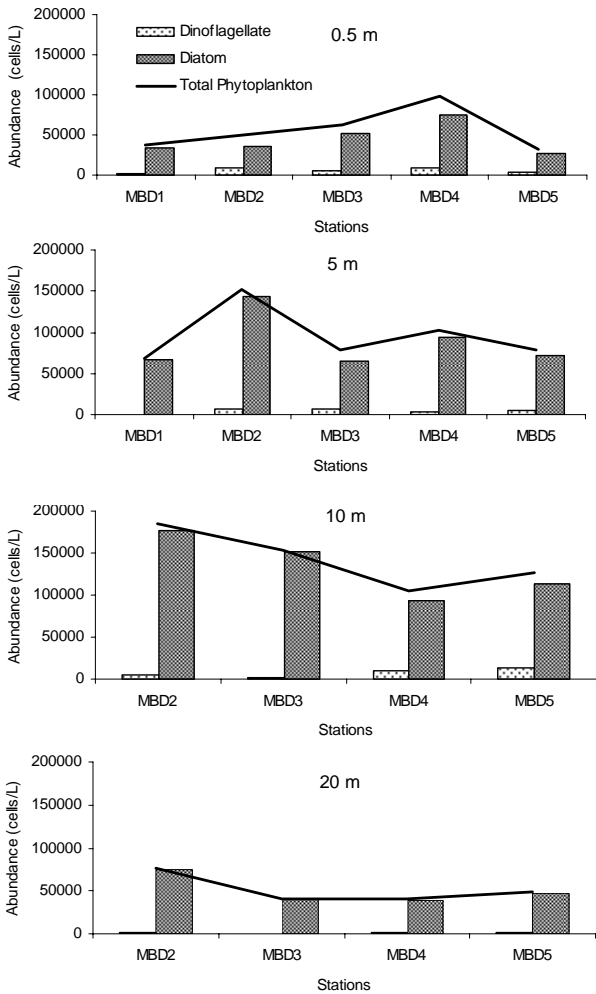


Figure 2. The phytoplankton abundance in the different stations at various depths.

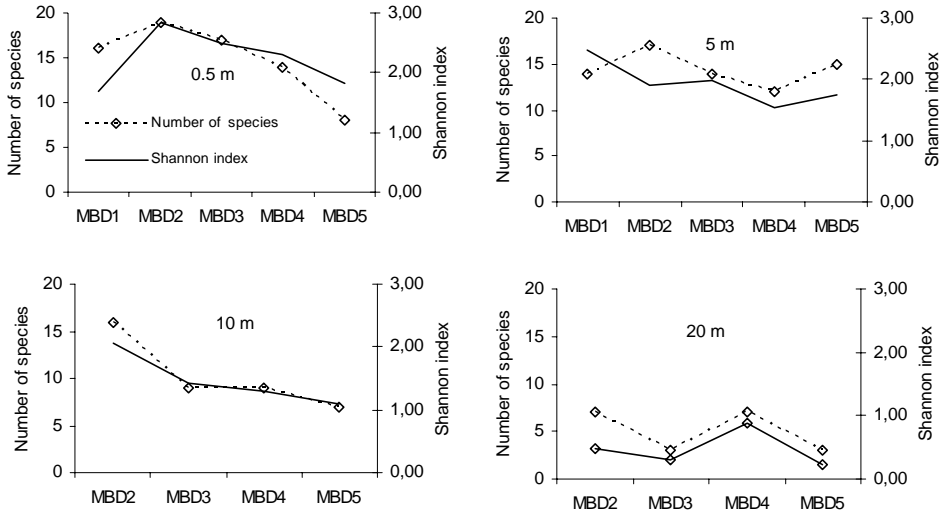


Figure 3. The spatial distributions of the number of species and diversity index

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°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 Türkođlu 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 komunitasinde kış mevsiminde (üst tabaka su sıcaklığı 7-9°C, tuzluluk 22-24 psu arasında) gözlenen bir diatom artışı açıklanmaktadır. Bu amaçla örnekleme alanından alınan tüm örneklerde dört alg sınıfından toplam 49 fitoplankton taksonu belirlenmiştir. Bu taksonların büyük çoğunluğunu (%94) dinoflagellat ve diatomlar oluştururken diğerleri ise silikoflagellat ve öglenoid flagellat türlerinden oluşmaktadır. En sık rastlanan türler diatomlardan *Proboscia alata* f. *alata* (Brightwell) Sundström, dinoflagellatlardan *Ceratium fusus* (Ehrenberg) Dujardin türleridir. Tüm çalışma alanında kantitatif olarak *Proboscia alata* f. *alata* dominant türdür. En yüksek hücre sayısı 185×10^3 hücre l⁻¹ olarak hesaplanmıştır.. Diatomların diğer fitoplankton türlerine göre baskın grubu oluşturdukları gözlenmiştir.

References

- Balkıs, N. (2003). Seasonal variation in the phytoplankton and nutrient dynamics in the neritic water of Büyükçekmece Bay, Sea of Marmara. *J. Plankton Res.* 25: 703-717.
- Balkıs, N. (2004). List of phytoplankton of the Sea of Marmara. *J. Black Sea/Mediterranean Environ.* 10: 123-141.
- Beşiktepe, Ş. T., Sur, H. I., Özsoy, E., Latif, M. A., Oğuz, T. and Ünlüata, Ü., 1994. The circulation and hydrography of the Marmara Sea. *Prog. Oceanog.* 34: 285-333.
- Boney, A.D. (1989). New studies in biology. Phytoplankton. 2nd ed. Edward Arnold. London, p.118.

- Cupp, E.E. (1943). Marine plankton diatoms of the West Coast of North America. University of California Press, Berkeley, California, USA.
- Delgado, M., Fortuna, J.M. (1991). Atlas de fitoplancton del Mar Mediterráneo. *Sci. Mar.* 55: 1-133. Barcelona, Spain.
- Dodge, J.D. (1985). Atlas of Dinoflagellates. A Scanning Electron Microscope Survey. Botany Department, Royal Holloway & Bedford Colleges, (University of London) Egham, Surrey. Farrand Press, p.119.
- Drebes, G (1974). Marines phytoplankton eine auswahl der Helgolander planktonalgen (Diatomeen, Peridineen). Georg Thieme Ver. Stuttgart, p.180.
- Guillard R.R.L. (1978). Counting slides. In: Phytoplankton manual, (ed. A. Sournia) UNESCO, pp. 182-189.
- Hasle, G.R., Syvertsen, E.E., Steidinger, K.A., Tangen, K., Throndsen, J., Heimdal, B.R. (1997). Identifying marine phytoplankton. (ed. Tomas C.R.), Academic Press, San Diego, USA, p.858.
- Hay, B.J., Honjo, S., Kempe, S., Ittekkot, V.A., Degens, T., Konuk, T., Izdar, E. (1990). Interannual variability in particle flux in the south-western Black Sea. *Deep-sea Research* 37: 911-928.
- Hendey, N.I. (1964). An introductory account of the smaller algae of British Coastal water Part V: Bacillariophyceae (Diatoms). London.
- Pielou, E.C. (1975). Ecological Diversity. Dalhousie University, Halifax, Nova Scotia. Printed in the USA. pp. 14-18.
- Ricard, M., Dorst, J. (1987). Atlas du phytoplankton marin diatomophycées. Membre de l'Institut. Vol.II: Editions Du Centre National De La Recherche Scientifique Paris.
- Sukhanova, I.N. (1978). Settling without the inverted microscope. In: Phytoplankton manual, (ed. A. Sournia) UNESCO, p. 97.
- Throndsen, J.(1978). Preservation and storage. In: Phytoplankton manual, (ed. A. Sournia) UNESCO, pp. 69-74
- Türkoğlu, M. and Koray, T. (2002). Phytoplankton species' succession and nutrients in the southern Black Sea (Bay of Sinop). *Turkish J. Botany* 26: 235-252.
- Utermöhl, H. (1958). Zur Vervollkommung quantitativen Phytoplankton-Methodik. *Mitt. int. Ver. theor. angew. Limnol.* 9: 1-38.

Zar, J.H. (1984). Bioistical analysis. Second edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Zeitzschel, B. (1978). Why study phytoplankton. In: Phytoplankton manual, (ed. A. Sournia) UNESCO, pp. 1-5.

Received: 17.01.2007

Accepted: 26.01.2007