Indian Journal of Marine Sciences
Vol 33(4), December 2004, pp. 365-368

Short Communication

Abundance and distribution of cyanobacteria *Synechococcus* spp in the south-eastern Black Sea during 2001 summer

[*]A. Muzaffer Feyzioglu, Ilknur Kurt, Muhammet Boran, Nuket Sivri
Karadeniz Technical University, Faculty of Marine Sciences, 61530 Camburnu Trabzon, Turkey
*[E-mail:muzaffer@ktu.edu.tr]

Received 3 November 2003, revised 13 July 2004

Abundance and distribution of unicellular cyanobacteria *Synechococcus* spp were studied during July 2001. Samples were collected from four different depths covering above the thermocline. Nitrate concentrations ranged from 0,005 μg at-l^{-1} off Trabzon and Hopa to 1.284 μg at-l^{-1} off Giresun. The highest concentration of *Synechococcus* spp. was at off Giresun at 25 m (6000 cell ml^{-1}) and off Rize (3700 cell ml^{-1}) at suface. Cyanobacteria cell counts were low at 5 and 10 m depths. The picoplanktonic abundance varies with nutrients in the Black Sea and it is quite lower in July 2001 somewhat similar to those observed in the oligotrophic Atlantic waters.

[**Key words:** Cyanobacteria, *Synechococcus*, Black Sea]

The importance of the picoplanktonic cyanobacteria in oceanic phytoplankton communities is well established[1]. In a large number of the marine systems, picoplankton, a diverse group united by size < 2 μm, is the dominant component of the planktonic food webs. This group includes heterotrophic bacteria, two types of photosynthetic prokaryotes (Cyanobacteria) *Synechococcus* and *Prochlorococcus*[2,3]. Pico-planktonic cyanobacteria *Synechococcus* spp, are known to be major contributors to the total photosynthetic biomass in the oceans[3] and unicellular organisms of the genus *Synechococcus* are some of the major forms of cyanobacteria in the open oceans, particularly in warm waters[4].

Many studies have been carried out in the oceans about microbial flora which includes *Synechococcus*[5,6]. Although, many studies have been carried out in the world oceans, almost nothing is known about the microbial food web that supports metazoan food webs via biomass production of both heterotrophic and autotrophic tiny cells in the southern Black Sea. In recent years a couple of studies were emerging on autotrophic picoplanktonic organisms from the area[7-10] . Though the distribution of *Synechococcus* spp was reported from southern Black Sea, there is no data on the summer distribution of *Synechococcus* in the region. Most of the studies in the region were carried out in spring and autumn.

The objective of this study was to examine the vertical and spatial distribution of *Synechococcus* spp above thermocline, and provide background information on the occurrence and distribution of *Synechococcus* spp in the south eastern Black Sea region in July 2001.

The Black Sea summer 2001 cruise was carried out from July 7 to July 13, 2001 aboard the *R/V Denar* (Research Vessel of the Faculty of Marine Sciences, Karadeniz Technical University). Sampling for various physicochemical parameters and for cyanobacteria was carried out at six stations (Fig. 1). Water sample for nutrient and *Synechococcus* were taken from upper mixed layer above the thermocline which include 0, 5, 10, and 25 m depths. All samples

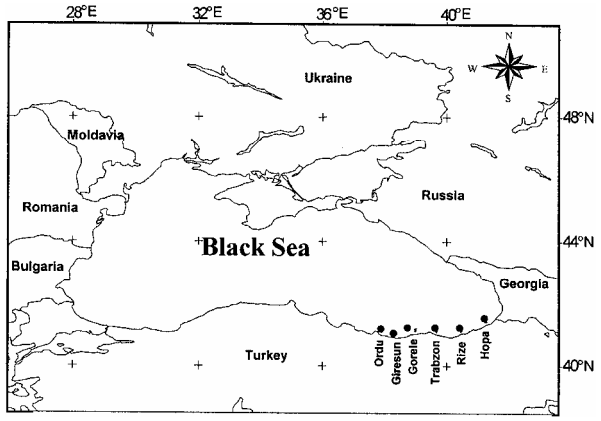

Fig. 1 - Location of sampling stations in the South Eastern Black Sea

were collected during the day time. Physical parameters (salinity, temperature and density) were collected using a CTD probe. Water samples were collected using 9 liter capacity teflon Van-Dorn bottles for nutrient analysis. Nitrate, nitrite and phosphate concentrations were measured followed standard methods[11].

For *Synechococcus* counts, water sample were drawn from the Van-Dorn bottles into 100 ml, dark-coloured bottles and preserved with 4% buffered formalin. About 10 ml from each water sample were filtered onto 0.2 μm pore diameter, 25 mm diameter, black, polycarbonate, (Nuclepore) membrane filters. The filters were then placed onto glass slides for counting on a Nikon E 600 Epifluorescent microscope at x 400 and x 1000 with a filter combination of B-2A (DM 505, EX 450-490 and BA 520) and G-1A (DM 575, EX 546/10 and BA 580) . *Synechococcus* was determined on the basis of orange fluorescence due to the presence of phycoerythrine[12]. For each sample, a minimum 40 randomly chosen microscope fields were counted [10].

CTD profiles for the transect are given in Fig. 2. There was no difference in CTD profiles among the sampling stations except off Hopa (Fig. 2. F). Temperature profile off Hopa clearly indicates presence of well mixed surface layer, extending down to 20 m. But other sampling stations did not show well mixed surface water, as observed off Hopa. CTD profiles show that thermocline developed between 22 and 50 m at all samcpling stations. Surface water salinity varied between 18-20 ‰. Salinity was lower at depths between 10 and 35 m. Below 35 m the salinity gradually increased and more saline waters were observed towards bottom layer.

Nutrient concentrations as well as changes in cell abundance with depth are given in Table 1. Nitrate concentration at off Giresun was significantly different than off Trabzon and off Hopa ($P<0.001$). It was the lowest off Hopa and the highest off Giresun. Nitrite varied similar to nitrate. While the lowest nitrite concentration in the surface waters were observed off Hopa and off Gorele, the highest were measured off Ordu surface water. Maximum nitrite value (0.252 μg-at l^{-1}) occurred at surface water off Ordu. Phosphate showed almost homogeneous distribution at all sampling stations excluding off Ordu and off Trabzon. While at station off Trabzon (0.049 μg-at l^{-1}) had the minimum phosphate concentration at the 5 m depth, the highest concentration was observed (0.636 μg-at l^{-1}) in station off Rize at 5 m depth.

The lowest cell density of the *Synechococcus* spp was observed at 5 m (38 cells ml^{-1}) and the highest

Table 1- Nutrients and *Synechococcus* spp distributions in sampling stations

	Depth	Sampling location					
		Ordu	Giresun	Görele	Trabzon	Rize	Hopa
Nitrate (μg-at l^{-1})	0 m	0.461	1.284	0.485	0,036	0,394	0,005
	5 m	0.647	1.267	0.457	0,063	0,243	0,005
	10 m	0.061	0.162	0.404	0,005	0,171	0,009
	25 m	0.081	0.374	1.021	0,027	0,027	0,041
Nitrite (μg-at l^{-1})	0 m	0,252	0,039	0,001	0,019	0,039	0,001
	5 m	0,001	0,001	0,058	0,019	0,001	0,039
	10 m	0,078	0,001	0,001	0,058	0,019	0,019
	25 m	0,001	0,039	0,039	0,001	0,001	0,155
Phosphate (μg-at l^{-1})	0 m	0,049	0,294	0,147	0,245	0,343	0,343
	5 m	0,098	0,147	0,392	0,049	0,636	0,098
	10 m	0,098	0,343	0,294	0,343	0,098	0,147
	25 m	0,294	0,538	0,392	0,049	0,343	0,294
Synechococcus spp (cells ml^{-1})	0 m	160	240	180	190	3700	120
	5 m	120	190	170	110	170	38
	10 m	74	230	77	3000	120	170
	25 m	340	6000	400	2600	690	39

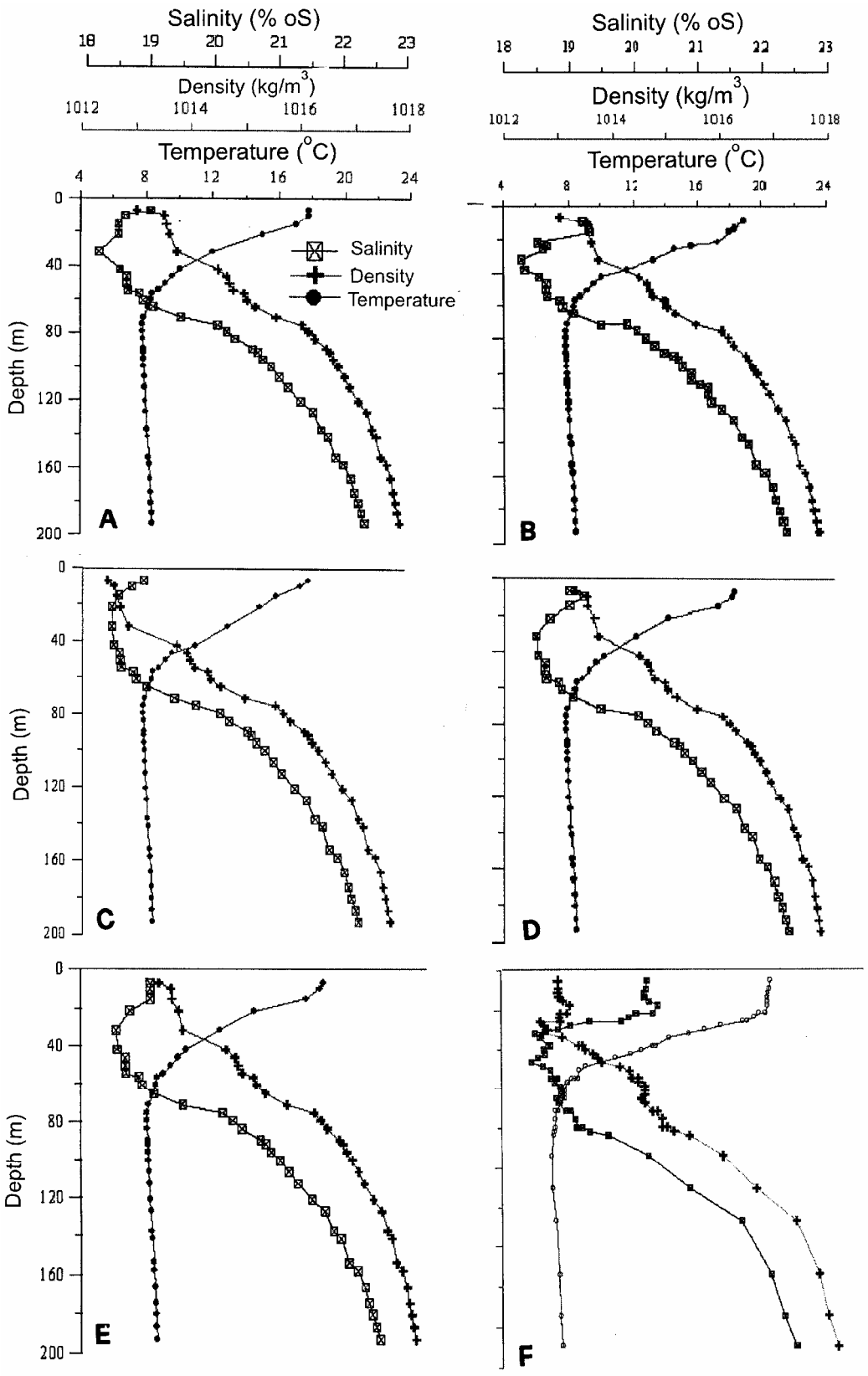

Fig. 2 - CTD profiles of sampling stations during the July 2001 cruise.

(6000 cells ml^{-1}) at 25 m. Samples taken from 25 m depth at Giresun and Trabzon stations indicated that the counts of the *Synechococcus* were higher than those at other stations . On the contrary, those of *Synechococcus* in the surface waters off Rize were higher than all other locations. Off Hopa the lowest *Synechococcus* spp biomass was found. Average cell counts at surface, 5 m, 10 m and 25 m depths were as 765, 133, 612 and 1680 cell ml^{-1} respectively.

According to earlier report in the south western Black Sea, *Synechococcus* spp cell numbers increased almost twice from surface to 25 m depth[10] which is similar to the trend observed in this study. *Synechococcus* cell numbers increased from surface to 25 m in the south-eastern Black Sea except off Rize and off Hopa . In addition, significant positive correlation was observed between cell numbers and salinity (r = 0.72). Although the highest cell abundance coincided with high concentrations of phosphate, the lowest cell abundances coincided with low concentrations of nitrite. Statistically no significant relation was seen between cell number and nutrient concentrations at any sampling stations.

Though the abundance of *Synechococcus* spp varied among the sampling locations, they were present in the photic layer at all stations. In the oligotrophic waters of the Atlantic ocean[13], their quantity was reported to be about 1000 cells ml^{-1} but did not exceed 4000 cells ml^{-1}. In the surface water of the Atlantic Ocean near the upwelling region up to 10^6 cells ml^{-1} *Synechococcus* spp have been reported[13]. Recently, Uysal[10] reported that the average cell concentration of 1.09×10^5 ml^{-1} in the surface waters of the south western Black Sea. Uysal[9] also showed that *Synechococcus* were much more abundant in offshore surface water than near coastal regions under the direct influence of the Danube river in western Black Sea.

Even though the Black Sea is known to have eutrophic character, when we compared our results with Zubkov's[13] Atlantic transect results, it seems during the summer (July 2001) period the cell number were similar to those in oligotrophic water of Atlantic ocean. Also the cell numbers recorded in the present study were much lower than those reported by Uysal[9,10]. Differences in the cell numbers could be due to sampling season and location of stations. Kurt[7] also reported that cell concentrations suddenly increased in August 2001 samples and reached 4.2×10^4 cells ml^{-1} at the surface water.

When we refer to literature[7-10] off Trabzon, it can be concluded that the lowest level of cell counts were observed in July and then anticipated increase in consequent months at the southeastern Black Sea coast. However, this increase is not as high as the increase in May. Observation of relatively low number of *Synechococcus* in this study may be due to the method that we used to preserve and count samples.

In a brief, as in the other marine environment, spatial and temporal dynamics of *Synechococcus* spp are vital information in describing productivity of an ecosystem. In July 2001, low number of *Synechococcus* cells may cause lower picoplanktonic productivity in the south-eastern Black Sea coast.

References

1 Stockner J G & Antia N J, Algal picoplankton from marine and fresh water ecosystem: Multidisciplinary perspective, *Can. J. Fish. Aquat. Sci.*, 43(1986) 2472-2503.

2 Johnson P J & Sieburth J M, Chroococcoid cyanobacteria in the sea: A ubiquitous and divers biomass, *Limnol. Oceanogr*, 24(1979) 928-935.

3 Chisholm S W, Olson R J , Zettler E R , Waterbury J B, Georicke R, & Welschmeyer N, A novel free-living prochlorophyte occur at high cell concentration in the oceanic euphotic zone, *Nature*, 334(1988) 340-343.

4 Murphy L S & Haugen E M, The distribution and abundance of phototrophic ultraplankton in the north Atlantic, *Limnol. Oceanogr*., 30(1985) 47-58.

5 Li W K W, Annual average abundance of heterotrophic bacteria and *Synechococcus* in surface ocean waters, *Limnol. Oceanog*., 43 (1998) 1746-1753.

6 Phlips, E J, Badylak S & Lynch T, Bloom of the picoplanktonic cyanobacterium *Synechococcus* in Florida Bay, a subtropical inner-shelf lagoon, *Limnol. Oceanogr*., 44 (1999) 1166-1175.

7 Kurt I, *Seasonal and spatial distribution of cyanobacterium Synechococcus* spp. *which influences to primary production in Black Sea*, M Sc. Thesis, Karadeniz Technical University, Turkey, 2002 (in Turkish).

8 Uysal Z, Chroococcoid cyanobacteri *Synechococcus* spp.in Black Sea: Pigment, size, distribution, growth and diurnal variability, in: *1st. National Marine Science Conference*, edited by Z Uysal and I. Salihoglu (30 May -2 June, Ankara, Turkey), 2000; pp 80-85 (in Turkish).

9 Uysal Z, Pigment, size, distribution of *Synechococcus* spp. in the Black Sea, *J. Mar. Syst.* 24(2000) 313-326.

10 Uysal Z, Chroococcoid cyanobacteria *Synechococcus* spp. in the Black Sea: Pigment, size, distribution, growth and diurnal variability, *J. Plankton Res*, 23 (2001) 175-189.

11 Parsons T R, Maita Y & Lalli C M, *A manual of chemical and biological methods for seawater analysis*, (Pergamon Press, Oxford), 1984, pp. 171.

12 Olson R J, Chisholm S W, Zettler E R & Armbrust E V, Pigment, size and distribution of *Synechococcus* in the North Atlantic and Pacific oceans, *Limnol. Oceanogr*., 35 (1990) 45-48.

13 Zubkov M V, Sleigh M A. Tarran G A, Burkill P H & Leakey R J K, Picoplanktonic community structure on an Atlantic transect from 50° N to 50° S, *Deep-Sea Res., Part I*, 45 (1998) 1339-1355.