Heterotrophic nanoflagellate and bacteria dynamics in South Eastern Black Sea during late Spring 2010

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Abstract

Heterotrophic nanoflagellate (HNF) and heterotrophic bacteria (HB) are major component of the microbial loop in the marine ecosystem. However, their dynamics and contribution to carbon cycling of the Black Sea ecosystem is poorly known. For understanding of temporal and spatial changes in abundance and biomass of HNF and HB together with environmental variables were monitored monthly in the South Eastern Black Sea during late spring 2010. Seawater samples were taken 10 meter intervals from surface to 60 meter depths in two stations which were located neritic and oceanic waters. Nikon E 600 Epifluorescence microscope and the image analysis system were used for estimating cell numbers and carbon biomass of HNF and HB.

According to our results HNF and HB abundance range from 3,16 x10^2 cells ml^-1-14,08 x10^3 cells ml^-1 and 1,12 x10^6 cells ml^-1-3,62 x10^6 cells ml^-1, respectively. Although the maximum cell number of HNF was found in coastal surface water in May, maximum abundance of HB was found at above thermocline in stratified waters at June in during sampling period.

Keywords: heterotrophic bacteria, heterotrophic nanoflagellate, Black Sea
INTRODUCTION

Black Sea is the world’s largest semi-enclosed marginal sea with a physical and chemical structure that is determined by its hydrological balance (Caspers, 1957; Sorokin, 1983). It is characterized by narrow continental shelf area in southeastern Black Sea part. Pelagic life restricted by anoxic waters below approximately 200 m depths. Not only autotrophic process but also chemotropic process was important throughout the water column. In the coastal ecosystem land-sea interaction is regulated by water run-off from the river system.

Combined with diminishing anthropogenic nutrient load and more limited nutrient supply into the surface water due to stabilizing effect of relatively warm winter conditions switch to high production regime of phytoplankton to its “background” low productive regime. Most of the researchers have started to talk about regime shift on ecosystem (Oğuz, 2006, Oguz & Gilbert 2007). Last decade major phytoplanktonic group ratio also changed. In the planktonic populations dinoflagellate diversity has increased but diatom diversity has dramatically decreased (Feyzioğlu & Seyhan, 2007). So trophic status of the Black Sea has shift to mesotrophy on the southeastern part, especially.

Bacteria, nanoflagellates and ciliates constitute the “microbial loop” which is a distinct and important element of the trophic food web in aquatic ecosystems affecting carbon and nutrient flows (Pomeroy 1974, Azam et al. 1983, Sherr and Sherr 1984). Heterotrophic bacteria (HB) play a key role in biogeochemical cycles of marine ecosystem and are the major consumers of dissolved organic carbon (DOC) (Bai et al, 2005, Fuhrman, 1995; Barbosa, 2001) Grazing by Heterotrophic nanoflagellates (HNF) this portion of carbon is promoted to higher trophic levels.

Although their importance little known about HB and HNF abundance and biomass in the Black Sea. For understanding of temporal and spatial changes in abundance and biomass of HNF and HB together with environmental variables were monitored monthly in the South Eastern Black Sea during late spring 2010. Present study includes early results of this monitoring programme.

MATERIALS AND METHODS

Study area and Sampling

Sea water samples were collected at two stations which are located coastal (YK1) and offshore (AD 1) waters in the southeastern part of Black Sea during late spring 2010 on board
R/V DENAR (Fig.1). Water depths of the stations were 250 m and 750 m. Water samples collected with Niskin bottles mounted on a Seabird SBE 50 rosette sampler from 0, 10, 20, 30, 40, 50 and 60 m layers were immediately fixed with glutaraldehyde (final conc. 1%) and stored at 4°C for further analysis. All samples were processed within 2 weeks. Besides these microbial parameters for the seawater samples collected, water temperature, salinity, and concentration of dissolved oxygen (DO) were measured by using a CTD system (IDRONAUT, OceanSeven 316). Nitrite, phosphate and silicate were measured by using standard spectrometric methods (Parsons et al., 1984).

**Figure 1.** Sampling Stations

**Measurements and data analysis Bacterial abundance and cell volume.**

For the estimation of bacterial number and HNF number the acridine-orange direct count method according to Hobbie et al. was applied. Counts were performed under a Nikon epifluorescence microscope with a filter combination of B-2A (blue excitation, dichroic mirror DM 505, excitation filter EX 450-490, barrier filter BA 520). Mean cell volumes were estimated using image analysis system composed of a digital camera, computer and the image analysis software. To calculate carbon content of bacteria and heterotrophic nanoflagellates 77 and 220 fg carbon per cubic micron were used, respectively (Carlson et al., 1999; Borsheim and Bratbak, 1987).
RESULTS

Temperature, salinity, Dissolved oxygen and pH profiles obtained during sampling period were shown in figure 2. Over the sampling period, sea surface temperatures ranged from 9.52 to 22.42 °C. Seasonal thermocline was occurred at 30 m depth in May. As a seasonal pattern, temperature was lowest in April, increased rapidly as the seasons progressed, reaching >20 °C in June. The salinity ranged from 16.83‰ to 17.71‰. Dissolved oxygen value range between 8.24-10.1 mg l⁻¹ at surface water. No significance differences were found at CTD profiles between coastal and offshore station. Nitrite concentrations in sampling stations ranged from 0.01 µg-at l⁻¹ to 0.75 µg-at l⁻¹. At late spring period the highest phosphate values was 0.1 µg-at l⁻¹. Silicate concentrations were change between 0.01-0.39 µg-at l⁻¹.
Figure 2. CTD profiles in the sampling stations (Coastal(A) and offshore(B) stations in April, coastal (C) and offshore (D) stations in May, Coastal (E) and offshore (F) stations in June 2010.
During sampling period HB abundance (fig.3) ranged from $1.12 \times 10^6$ cells ml$^{-1}$ to $3.62 \times 10^6$ cells ml$^{-1}$. Bacteria abundance exhibited similar trend both of sampling stations. At the coastal station surface bacterial biomass range from $10.47 \times 10^6$ fgC ml$^{-1}$ in April to a maximum of $24.19 \times 10^6$ fgC ml$^{-1}$ in May. In contrast to, at the offshore station surface bacterial biomass range from $6.24 \times 10^6$ fgC ml$^{-1}$ in May to a maximum $42.08 \times 10^6$ fgC ml$^{-1}$ in April. Although maximum HB abundance was found at June, max mean volume was found in April. In both station maximum abundance of HB ($3.62 \times 10^6$ cells ml$^{-1}$) was found at above thermocline in stratified waters at June in during sampling period. Mean bacterial volume was measured $0.44 \mu m^3$ in April, $0.12 \mu m^3$ in May and June.

Cell numbers of HNF ranged from $3.16 \times 10^2$ cells ml$^{-1}$ to $14.08 \times 10^3$ cells ml$^{-1}$ at the sampling period. HNF abundance ($14.08 \times 10^3$ cells ml$^{-1}$) was the highest in May at coastal station (Fig. 4). In both station, vertical distribution HNF biomass was similar except for May 2010. At the coastal station surface HNF biomass ranged from $21.33 \times 10^6$ fgC ml$^{-1}$ to $166.33 \times 10^6$ fgC ml$^{-1}$ whereas at the offshore station $19.19 \times 10^6$ fgC ml$^{-1}$ to $66.82 \times 10^6$ fgC ml$^{-1}$.

![Figure 3](image-url)  
*Figure 3. Vertical profiles of HB abundance in coastal (A) and offshore (B) stations.*
Figure 4. Vertical profiles of HNF abundance in coastal (A) and offshore (B) stations.

HNF biomass decreased with depth. Mean cell volume of HNF were measured 19.99 µm$^3$ in April, 20.09 µm$^3$ in May and 24.18 µm$^3$ in June.

Compared with bacteria and HNF in the surface water, the biomass of which showed three and eight-fold changes throughout the study period ($6.24 \times 10^6$ to $42.08 \times 10^6$ fgC ml$^{-1}$ and $19.19 \times 10^6$ to $166.33 \times 10^6$ fgC ml$^{-1}$, respectively). Depth integration (0–60 m) of HB biomass ($54.04 \times 10^6$fgC ml$^{-1}$) was higher than HNF biomass in April after phytoplankton bloom period of southeastern part of Black Sea. Temperature stratification was occurred in May. The highest HNF biomass was seen in this period. After increasing the water temperature HB and HNF biomass ($31.07 \times 10^6$ fgC ml$^{-1}$ and $28.66 \times 10^6$ fgC ml$^{-1}$) were approximately equal each other in June 2010 (Fig. 5).
Figure 5. Mean biomass of HB and HNF throughout water column in sampling period.

REFERENCES


