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Research Article

Changes in the algocenoses in the estuary area of the Don River, Russia in different seasons

Murooj Abbas Buhlool AL-GHIZZI*[1,2], Shaimaa Talib ABEDALI[3], Elena N. BAKAEVA[4,5]

[1]*Southern Federal University, Academy of Biology and Biotechnology, Rostov-on-Don, Russia.*
[3]*Department of Biology, College of Education for Women, University of Thi Qar, Iraq.*
[4]*Department of Hydrochemical, Institute of Earth Science, Southern Federal University, Rostov-on-Don, Russia.*
**Email: muroojabas6@gmail.com*

Abstract
This study aimed to describe the seasonal dynamics of phytoplankton in the estuary area of the River Don, by comparing the seasonal and spatial patterns. The temperature and pH were measured during phytoplankton growth periods in 3 seasons of 2019. Diatoms formed the largest taxa of the phytoplankton and biomass of phytoplankton (67.56% of the total species composition in spring at station 4). Total number of phytoplankton was 413.33 to 1030 (Cell*103/L), while phytoplankton biomass ranged 33.94-1028.03mg/l. In the early spring, *Nitzschia* sp. and *N. scalaris*, *N. subtilis*, *Melosira varians*, *Cyclotella meneghiniana*, in summer, *N. distans* and *Cyclotella meneghiniana*, *M. varians*, *N. scalaris*, *eptocylindrus minimus* were dominant. Based on the results, the abundance peaks for blue-green algea occur in summer.

Keywords: Phytoplankton, Biomass, Relative abundance, Spatial and seasonal variation, River Don.

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Introduction

Phytoplankton are vastly present in the water bodies having essential role in aquatic ecosystem. In any aquatic environments, algae are the most important primary producer; they occupy the primary place in autotrophic nutrition in the food chain of the ecosystem. Sinha & Srivastava (1991) and Muhammad et al. (2005) noted that the production of phytoplankton is high when environmental effects are at the normal state. An effective bio-indicator for water quality is the structure of phytoplankton (Peerapornpisal et al., 2004). A study on the phytoplankton community, especially the species richness, their biomass, and their ratios have one of the methods to determine the water quality condition (Jafari & Gunale 2006). In aquatic environments, algae have been used as indicators for a long period of time (Battarbee et al. 1986; Michelutti et al. 2001; Simboura & Zenetos 2002; Muriel et al. 2004; Smol & Stoermer 2010; Oberholster et al. 2010; Jafari & Alavi 2010; Bere & Tundsi 2011).

Many factors affect the distribution of organisms e.g. any change in water temperature causes the variation in species structure, metabolic rate and increase the solubility of toxic substances (Hodges 1989). Hence, the important environmental parameters i.e. availability of nitrogen and phosphorous can modify the productivity of the aquatic ecosystems (Wetzel & Likens 2000). Using of total biomass of phytoplankton and diversity of phytoplankton as indicators for assessing water pollution is a proper tool due to their high sensibility

Table 1. The study area included 8 stations on the Don River within Rostov-on-Don.

Sample number	Sampling points locations	Sampling horizon, m
1	The Don river, Rostov-on-Don, above the Aksai river branch	0.3
2	The Don river, Rostov-on-Don, above the new water intake	0.3
3	The Don river, Rostov-on-Don, below the confluence of the Temernik	0.3
4	river	0.9
5	The Don river, Rostov-on-Don, 100 m below 2nd spillway	0.3
6	The Don river, Rostov-on-Don, 500 m below 2nd spillway	0.3
7		4.5
8	The Don river, Rostov-on-Don, 900 m below 2nd spillway	0.3

to environmental changes (Reynolds 1997; Reynolds et al. 2002; Brettum & Andersen 2005). Presence of Cyanobacterian can be as a result of exposure to nutrient enrichment (Reynolds 1984a; Moss 1998). Therefore, the objectives of this work is to identify the phytoplanktons and their changes in the estuary of the Don River i.e. its structure in different stations with anthropogenic influences.

Materials and Methods

Study area: The Don River is one of the largest rivers in the European part of Russia. Its length is 1870km with a catchment area of 442000km^2. The distance of the lower Don from the Tsimlyansk reservoir to the Taganrog Bay is 313km (Lurye & Panov 1999). The Don estuary is located downstream of the city of Rostov-on-Don. The river depletes about 340km^2 yearly (Mordukhai-Boltovskoy 1940; Yearbook 1988). The study area included eight stations on the Don River within Rostov-on-Don area (Table 1).

Sampling: The collecting of water samples was done from spring to autumn 2019 in eight stations. Samples of the phytoplankton were taken from subsurface water (30cm) and then preserved in the formalin's solution (2%) (Sournia 1978). The slides of phytoplankton from each sampling stations were prepared to identify and count the composition of the phytoplankton and the relative ratios of each taxonomic group. Identification of species was done under a compound microscope, according to the proper identification keys (Zabelina et al. 1951; Gollerbach et al. 1953, Popova 1955; Dedusenko-Schegoleva et al. 1959; Germain 1981; Prescott 1982). The total species density and phytoplankton biomass (mg/L) were calculated as the sum of the densities of each species in all months as well as the average of season, and the relative abundance for all species.

Results and Discussions

During the study period, the water temperature varied from 14.95°C in spring to 24.4°C in summer, and pH from 7.71 in Autumn to 8.25 in spring (Fig. 2). Total number of phytoplankton was recorded as 413.33 to 1030 (Cell*10^3/L) and their biomass from 33.94 to 1028.03mg/l.

A total of 160 species was recorded belonging to 6 classes. During three studied seasons, taxa of diatoms (70 species), green algae (40), blue-green algae (42), dinophytic (1), and yellow algae (7) were recorded. A high species diversity of the phytoplankton in the study area was noted in summer and autumn seasons. The dominant species in the early spring period was *Nitzschia* sp. Hass. and *N. scalaris* (Her.) W. Smith, *N. subtilis* (Kützing) Grunow, *Melosira varians* C. Agardh, *Cyclotella meneghiniana* Kützing, and in summer *N. distans* W. Gregory, *C. meneghiniana* Kützing., *M. varians* C. Agardh, *N. scalaris* (Ehrenberg) W. Smith. and *Leptocylindrus minimus* Gran. At all the studied stations, one main maximum total phytoplankton abundance was found in the summer (Fig. 3). Seasonal fluctuations in phytoplankton populations may be associated with changes in environmental factors (Antoine & AL-Saadi 1982).

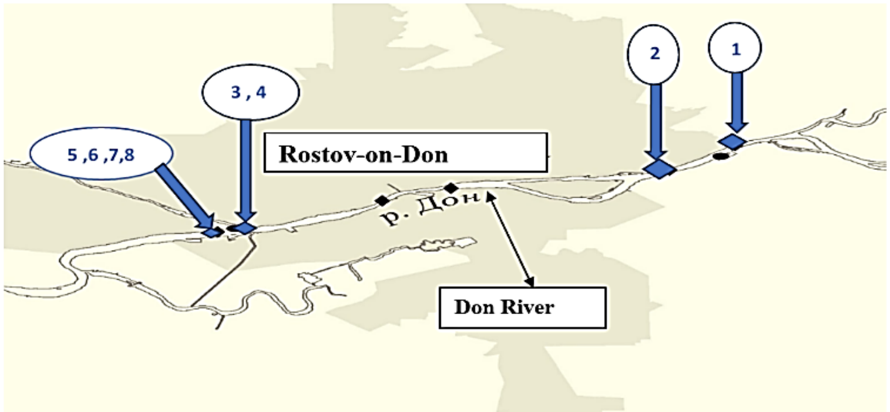

Fig.1. Studied area on Don River in Rostov-on-Don city, Russia.

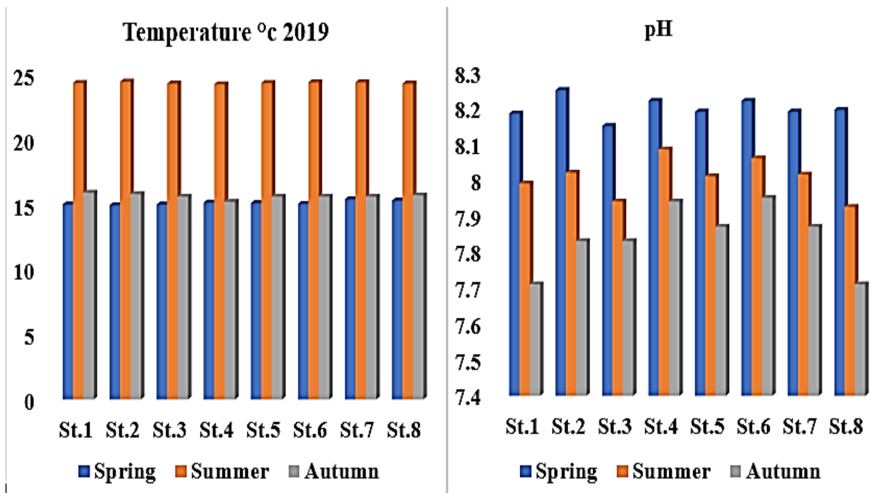

Fig.2. Seasonally Variation of the temperature and pH for all stations.

Station 6 showed a higher total number of phytoplankton, which may be due to the high values of the household nutrients dumped at this station (Hassan 1993).

According to Reynolds (1998), the species community changed as a result of the survival strategy in in different ecosystems. In a few years ago, prove that conducting an analytical study of the spatial and temporal changes in the biomass and density of phytoplankton is using by the morphological and physiological properties of the major groups of phytoplankton (Becker et al. 2010; Yang et al., 2011; Gillett et al., 2015; Li et al., 2017).

The station at the water intake and below the spillway showed increase of the biomass in stations 1, 3 and 7 in summer. Whereas, the total numbers of phytoplankton recorded a spatial difference from the biomass in summer. The total number of phytoplankton was showed an increase in stations 2 and 5, which was offset by a decrease in the total biomass. No spatial difference in total numbers of phytoplankton and total biomass was found in spring (except station 6 in total number) and autumn. The total number of phytoplankton and total biomass had no different between stations in spring and autumn due to the horizontally well-mixed waters.

The relative abundance of Bacillariophyceae and Chlorophyceae was 35.62-67.56 and 31.07-101.11%, respectively, while relative abundance of Cynophyceae and Euglenophyceae were 6.61-31.56 and 10.10-24.86%, respectively. The relative

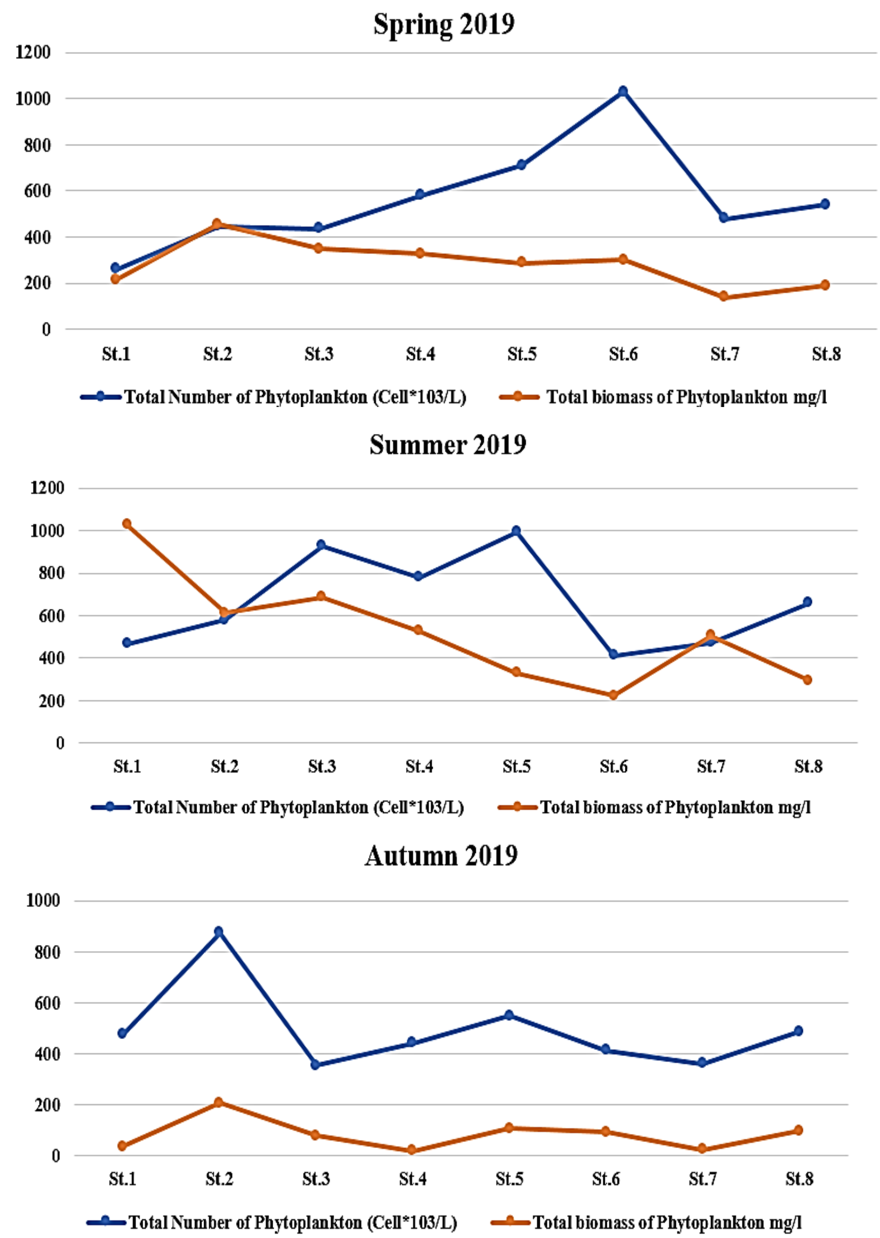

Fig.3. Seasonally Variation of the total number of phytoplankton (Cell*103/L) and biomass for all stations.

abundance of phytoplankton dominated by Bacillariophyceae and Chlorophyceae in spring due to moderate temperatures and relatively high nutrients in this season. The increasing of Bacillariophyceae in the spring should therefore may related to the moderate temperatures. In addition, the relative abundance of chloraphyceae and Bacillariophyceae were high in unpolluted stations.

Relative abundance of Bacillariophyceae and Chlorophyceae was 20.91-48.33% and 14.08-33.57%, respectively, while relative abundance of Cynophyceae and Euglenophyceae ranged from 22.08-53.79 and 4.90-26.66%, respectively. In summer, the high total numbers of phytoplankton in station 2 and biomass in station 5 were related to the Cyanobacteria. This may be attributed to the high pH values in these seasons. The number of Cyanobacteria increased in the polluted environments compared to other species due to its

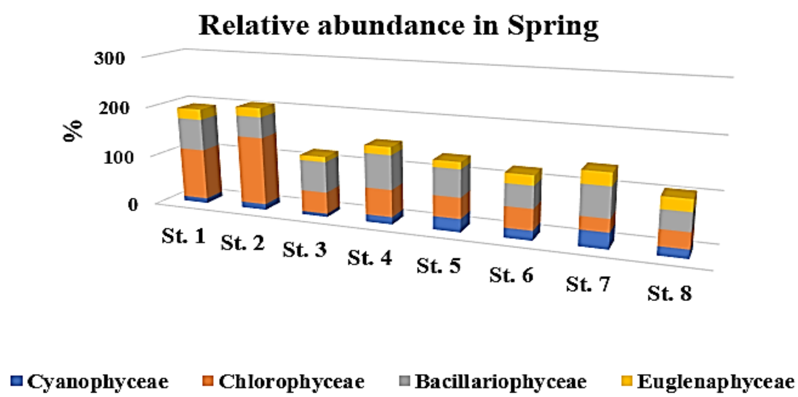

Fig.4. Relative abundance of phytoplankton groups in spring for all stations.

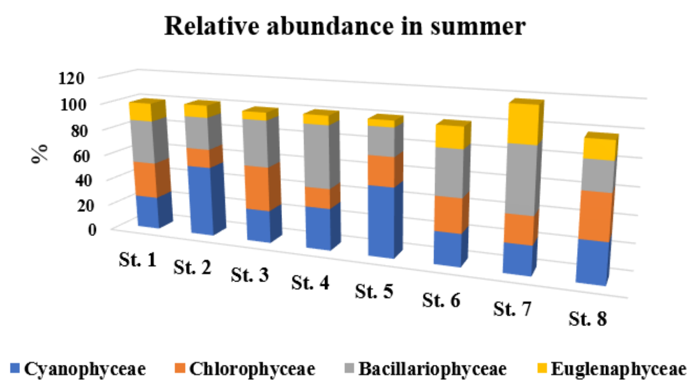

Fig.5. Relative abundance of phytoplankton groups in summer for all stations.

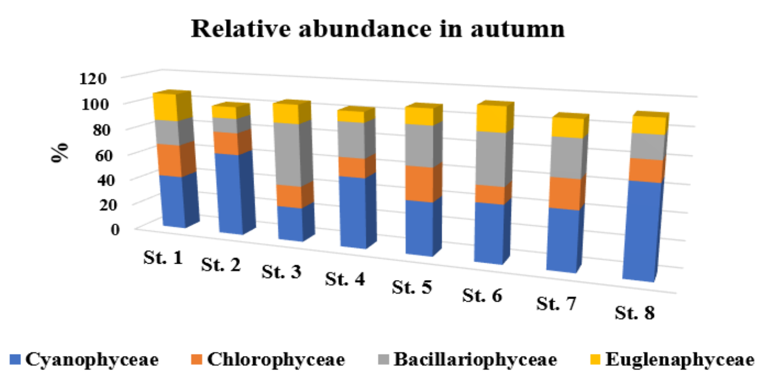

Fig.6. Relative abundance of phytoplankton groups in autumn for all stations.

ability to grow at high pH levels (Atici & Obali 2006; Okoth et al. 2009). In summer, the Cyanobacteria was high in line with the temperature values rise. Moreover, Chlorophyceae accounted for about 53.79% of the total phytoplankton in station 2. The differences in the seasons were corresponded largely with the model of surface water systems (Sommer et al. 1986).

The Bacillariophytes increased in the spring when nutrients increase and the density of Cyanobacteria increases in phytoplankton community when temperature is high (Kosten et al. 2012; Gillett et al. 2015). Chlorophyceae and Euglenophyceae were effected in summer may be due to water flow (Reynolds et al. 2002). Relative abundance of Bacillariophyceae and Chlorophyceae were 10.9-47.34 and 12.65-29.17%, respectively, while relative abundance of Cynophyceae and Euglenophyceae ranged 26.23-68.35 and 8.88-20.70%, respectively.

In autumn, cyanobacteria and Bacillariophyceae increased and this phenomenon may be due to rise of the nutrients in the aquatic environment, which in turn leads to a prolonged growing season cyanobacterial (Sommer et al. 1986; Kruk et al. 2002; Paerl & Huisman 2008).

Conclusions

In Don River, total number of phytoplankton and the biomass of phytoplankton was high in summer. The highest total number of phytoplankton was recorded in spring station 6 and in summer in stations 3 and 5, while the biomass was higher in autumn largely by increasing Cyanobacteri and Chlorophyta. The seasonal variation of phytoplankton in Don River revealed Bacillariophyceae and Chlorophyceae increase in spring when nutrients rise by increasing of Chlorophytes in beginning of summer and Cyanobacteria in mid-summer when temperature is high.

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