Asian Journal of Advances in Research

11(4): 136-143, 2021

STUDY OF DISTRIBUTION OF PHYTOPLANKTON UNDER DIFFERENT HYDROCHEMICAL FACTORS IN NORTHERN PART OF LATTAKIA COASTAL WATERS (SYRIA)

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AUTHOR'S CONTRIBUTION

The sole author designed, analysed, interpreted and prepared the manuscript.

Received: 08 September 2021
Accepted: 16 November 2021
Published: 20 November 2021

Original Research Article

ABSTRACT

Seasonal changes in chlorophyll a phytoplankton abundance and physico-chemical factors affecting these parameters were investigated in this study. Quantitative and qualitative phytoplankton and nutrient analysis were carried out in 2018 at two sampling stations in northern part of lattakia coastal waters in the northeastern Mediterranean coast of syria. Sampling was performed monthly from january to dezember of 2018 Nutrient concentrations were high in winter but low in summer. The concentration of, PO4-P, NO3+ N and [Si (OH)4]-Si in surface water varied in the range of 0 -1.1 μM, 0.2-9.1 μM and 0.06-13.5 μM, respectively. Surface water phytoplankton abundance reached the highest level (23.1×106 cells l-1) in March mainly due to the increase of a diatoms. It reached the lowest level in December (0.001×106 cells l-1). Chlorophyll a concentration ranged from 0.01 to 7.4 mg l-1 in surface water. Nutrient concentrations and phytoplankton biomass of the research area were found higher than those of the previous studies of other coastal areas in Syria.

Keywords: Phytoplankton; abundance; chlorophyll a; nutrients; eastern mediterranean sea.

1. INTRODUCTION

Eastern Mediterranean Sea is known as one of the most oligotrophic areas in the world based on biomass and primary production [1,2,3]. However, coastal areas show high productivity due to nutrient rich terrestrial inputs and anthropogenic effects. phytoplankton periodicity is affected by the different sources of land-derived nutrients and to their dilution patterns. The blooms are also one of the response of phytoplankton to environmental perturbations such as pollution [4]. Pollution pressure determined with investigation of the species composition, cell numbers and biomass.

The location of the research area is considered as a touristic place and is heavily populated during summer and under threat from pollutants coming from agriculture areas and industrial facilities. The input from the Streamlet and outfall of sewage canal which serve the around area.

Unfortunately, there are very few studies carried out on phytoplankton succession and abundance in Syrian coastal waters compared to other areas in the eastern Mediterranean. The first study in the region was carried out by [5] and a more recent one was performed by [6,7]. Therefore, this study was carried out to investigate the seasonal variations of the phytoplankton abundance and chlorophyll a at two

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stations in the northern part of Lattakia city in relation to changes in physic-chemical factors.

2. MATERIALS AND METHODS

The study was carried out at two stations in the coastal area of Eben Hani, located in northern part of Lattakia city, northeastern Mediterranean (Fig. 1). Samples were collected at monthly interval from January to December in 2018. The area of study extends for 5 km and, the choice of sampling stations was conducted according to the gradient of anthropogenic activities. Two stations were chosen with different environmental characteristics:

Station 1 (ST1): is located at 50 m from the discharge of stream, where the depth of water column is about 4 m. The area is influenced by sewer sanitation which serves the neighboring villages, and the discharge of fertilizer agriculture waste.

Station 2 (ST2): is located 2 km from the shore, where the depth of the water column exceeds 20 m and opened directly to the sea. The location is affected with discharge of sewage water, which serve the touristic hotels and houses around.

A standard phytoplankton net with 20-µm mesh size was used for Phytoplankton sampling. The samples were fixed in formaldehyde (4% final concentration). Uetermol method was using to determine the abundance of phytoplankton. An Olympus BX-50 model microscope were used for examination of the phytoplankton.

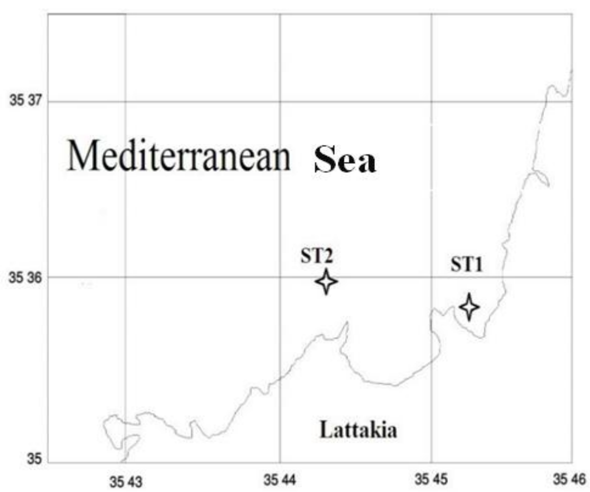

Fig. 1. Location of sampling stations

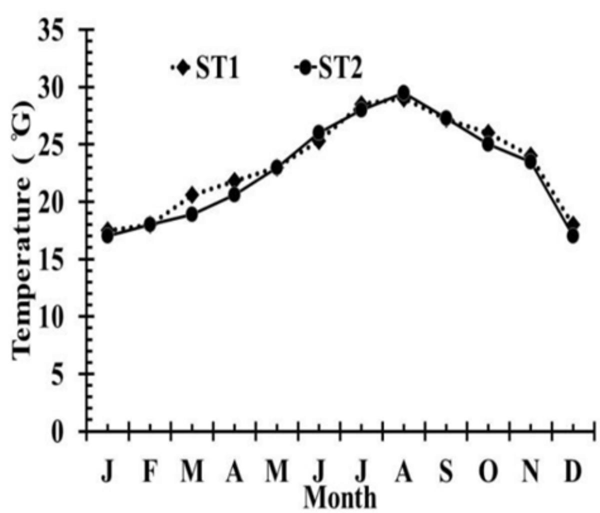

Fig. 2. Variations of temperature during research period

Surface water temperature and salinity were measured by using YSI model YSI. Analyses for PO4-P (phosphate), NO3+NO2-N (nitrate+nitrite), and [Si(OH)4]-Si (silicate) were done spectrophotometrically [8,9]. For chlorophyll a analysis, water samples were filtered through GF/F filter paper (0.7 µm pore size) and extracted in 90 % acetone. Then, chlorophyll a measurements were made according to Parsons et al. [9].

3. RESULTS

3.1 Physico-Chemical Factors

Seasonal changes in temperature and salinity in both sampling stations are shown in Fig. 2. The lowest temperature (17 °C) was recorded in January, whereas the highest in August was 29.5 °C. Salinity decreased to the lowest levels (38‰) in winter and reached the highest values (41.2‰) in summer due to the lack of rain and high evaporation Fig. 3.

Nutrients showed important seasonal cycles Figs. 4,5 and 6. The differences among seasons were statistically significant for all nutrients (nitrate, phosphate, and silicate) ($p<0.01$). The lowest (0.2 µM) and highest (9.1µM) nitrate concentrations were found in June and December respectively. Phosphate concentrations were below detection levels during summer, reaching the highest values of 1.1µM during winter at ST1. The lowest and highest silicate concentrations were 0.06 µM in June and 13.5 µM in January. Nutrient concentrations were higher at ST1, however differences among the stations were not statically significant ($p>0.01$).

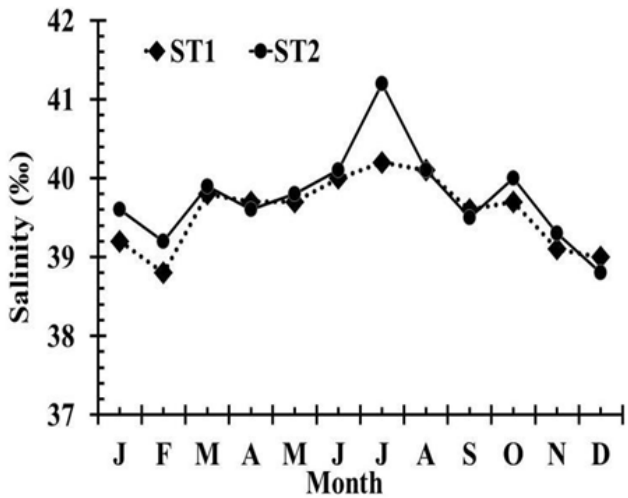

Fig. 3. Variations of salinity during research period

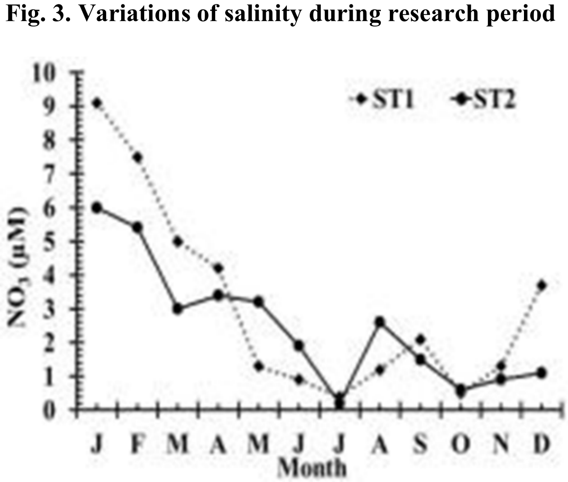

Fig. 4. Variations of nitrate during research period

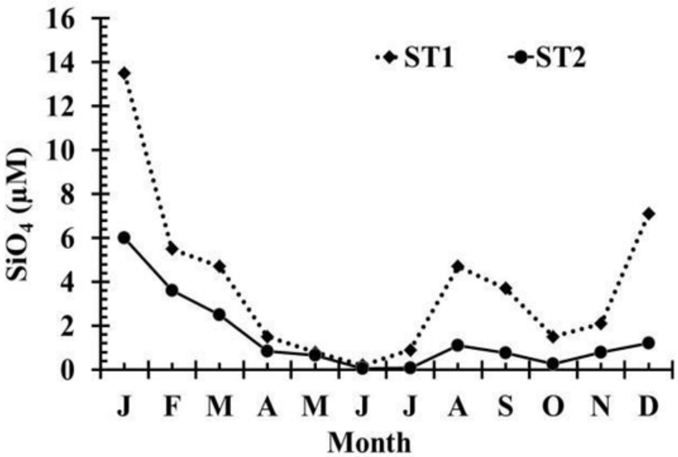

Fig. 5. Variations of silicate during research period

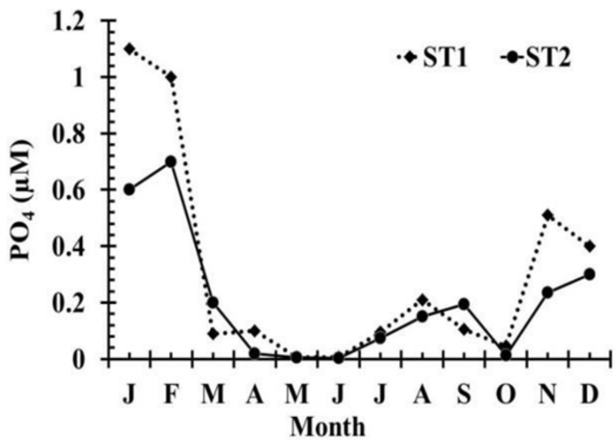

Fig. 6. Variations of phosphate during research period

3.2 Phytoplankton Abundance and Chlorophyll a

Phytoplankton biomass, estimated as chlorophyll a showed values between 0.01 and 7.4 µgL-1 Fig. 7. Chlorophyll values were found high in spring and the highest values were in March as 7.4 (station 2). The lowest reordered values were 0.01 in January (Station2). The differences in chlorophyll a value among the month was found significant ($P<0.01$), but the difference among the stations was not significant ($p>0.05$). A significant negative correlation ($r=-0.256$, $p<0.01$) was found between chlorophyll a and temperature, whereas the correlation of Chlorophyll a was positive with nutrients ($r=0.311$ for phosphate, $r= 0.618$ for nitrate and $r= 0.44$ for silicate, $p<0.01$.

A total of 96 phytoplankton taxa were determined. These include 51 taxa belonging to diatoms and 41 to dinoflagellates, Chlorophyta and cyanobacteria were represented with only 2 taxa each. Diatoms were dominant in terms of species and their abundance. The highest number of species was found in winter. The lowest phytoplankton species was determinate in July.

Phytoplankton abundances were high between a minimum 0.001 x 106 cells/ L-1 in December in both stations and a maximum between 15.4 and 23.1 cell/ L-1 at st1 and st 2 respectively and showed two important peaks, in spring and in autumn Fig. 8.

In phytoplankton succession, the most abundant species in late winter was the dinoflagellate, and in spring the diatoms. In November the species were dominant. In the summer, in addition to Nitzschia and from the diatoms, species of from Dinoflagellates were species. The genus Ceratium was represented by the highest number of species (6 species) during the summer.

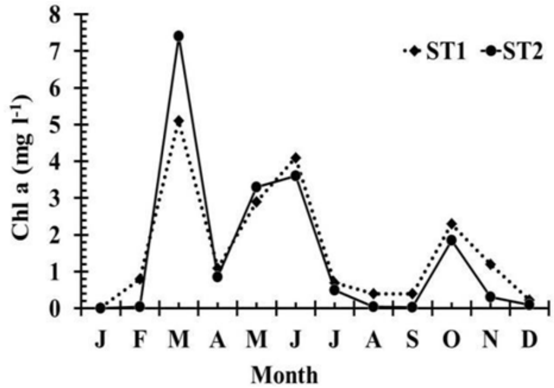

Fig. 7. variations of phytoplankton chlorophyll a during research period

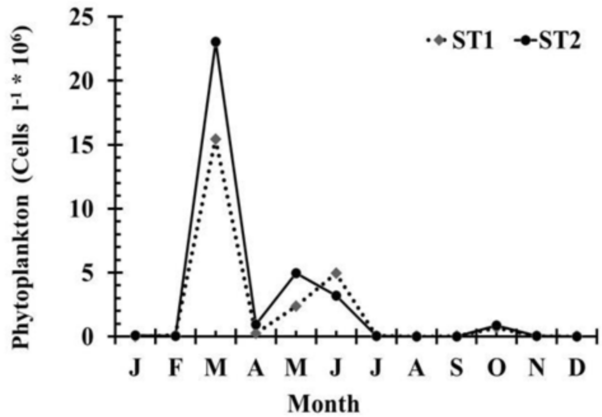

Fig. 8. Variations of phytoplankton abundance during research period

It was clear that diatoms were dominant in terms of cell numbers. The abundance of diatoms increased and reached 28, 3 in June. Dinoflagellates were lower to diatoms in termes of cell number. In Winter, dinoflagellate cell number were at the lowest level (600 cell/L-1). Only in March were dinoflagellate cell number higher than those of diatoms in both sites due to the increase in cell numbers of Dinoflagellattes reached cell/ L-1 during this period.

4. DISCUSSION AND CONCLUSION

Earlier studies on primary production, phytoplankton biomass and nutrients reveal the eastern Mediterranean to be of oligotrophic nature [10,11]. Oligotrophic in the eastern Mediterranean was attributed to insufficient land based nutrient deficiency in surface water nearby to anticyclonic regions due the natural structure of the region. Coastal areas may show different specification than open sea in terms of nutrient concentrations, phytoplankton biomass and primary production levels. In contrast to other areas in the Mediterranean, there has been very little published data on the environmental variables and phytoplankton along the Syrian Mediterranean coast [6,7,12,5]. The sampling area in the present study is located in northern part of the Lattakia coastal water, which is under the influence of agricultural efforts, inputs of sewage water and the other land-based sources of nutrients. Nutrient's concentrations were in high levels in both locations due to the several sewages outfalls and the discharge of the stream which carries phosphorous and nitrogenous fertilizers from agricultural areas around to the bay. Nitrate, phosphate, and silicate concentration reached their highest level in winter. Nutrient concentrations in general decreased to their lowest level in late spring due to an increase in phytoplankton abundance. In general, significant negative relationship were found between phytoplankton abundance and nutrient concentration (Nitrate $r = -0.47$, $p<0.01$; phosphate $r = -0.58$, $p<0.01$, silicate $r = -0.63$, $p<0.01$).

Chlorophyll a value ranged from 0.05 to µg. L-1 and reached its highest concentration in June. Chlorophyll a concentrations and phytoplankton cell numbers were

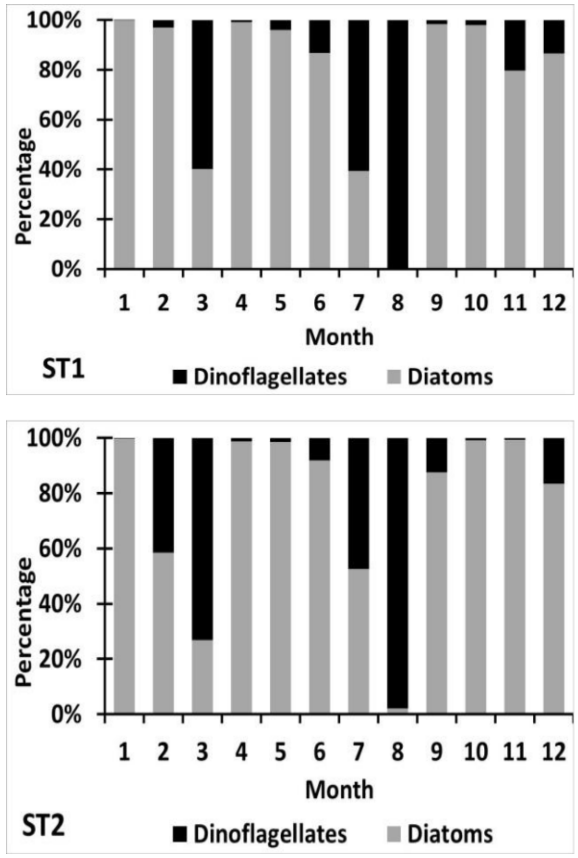

Fig. 9. Presence of dinoflagellates and diatoms in 2 sites

in low levels in summer months. However, there were two peaks in terms of cell numbers in Spring and autumn. It was conspicuous that chlorophyll a and phytoplankton abundance made peaks at the same months, as a result, The correlation between cell number and chlorophyll a was statically significant.

Monthly changes in species diversity and abundance of phytoplankton depend on Hydroclimatic- factor and

hydrological conditions. Phytoplankton abundance increased in this research in early spring as previously reported for different part of the syrian coastal water and the Mediterranean. Salinity decreased due to rain and freshwater input winter and no correlation was found between salinity and phytoplankton abundance.

In a comparative study of the species composition of phytoplankton between this study and previous findings in syrian coast water, we found in this study 4 new species [6,7], but not determinated at any of previous studies. Those spieces were dominant at both locations during the spring bloom of phytoplankton in the northern part of lattakia.

Diatoms and dinoflagellates comprised 88% and 11% as cell numbers respectively. The cell number of diatoms was the highest among the groups. The highest phytoplankton species was found in winter. phytoplankton abundance reordered in this study was higher than pervious Findings. The increase of phytoplankton abundant in the studying area may be due to increase of the influence of land-based input.

In the present study, the seasonal variation of Phytoplankton displays two peaks: a major one in May-June and 2^{nd} less important one in October [13,14,15]. In summer, during the water stratification, the phytoplankton at the surface water was very poor in quantity as well as in diversity. In winter the isothermic conditions and turnover of water masses are not suitable for phytoplankton growth, which keeps densities at low level. Phytoplankton abundance reached its highest in May. . The highest cell number was found in spring, which was attributed to the increase in cell number of. The occurrence of those species in the Syrian coastal water is unknown.

The increase in phytoplankton occurs usually at the end of winter and early spring period in the

Mediterranean [16,17,18]. In the present study, phytoplankton cell number showed significant fluctuation in different seasons. Cell numbers decreased in different seasons. The lowest cell number of phytoplankton were found in November and January, but an increase started in March. The number of phytoplankton species was low in spring; this may be a result of the dominance of *Ch.* reported that the diversity index declined to a minimum level when one or few species were dominant in phytoplankton blooms. The decrease of diversity of phytoplankton and increase of cell number in spring was due to the domination of three species. In our research the lowest diversity value for phytoplankton communities was found in summer. Dinoflagellate abundance was quite lower than diatoms. The spring bloom characterized by the diatoms. Dinoflagellates were dominant in early spring due to growth of the species. and in early summer was mainly due to increase of a dinoflagellate. The species is recorded for the first time in Syrian coastal water, but it was registered in coastal stations in Lebanese coastal water.

As can be seen from the results, there may be important changes in phytoplankton biomass and abundance for one year period. Although the research area is under the influence of land-based input, no clear response of phytoplankton was detected in terms of biomass, abundance, and diversity due to these effects. Nutrient concentrations in this coastal area reached relative high concentration. The high nutrient concentrations due to source stations, where the sewage outfall and the fertilizer agriculture waste is charged, allow the formation of eutrophic conditions. Besides, the results of phytoplankton community structure and abundance support this suggestion. It can be said that phytoplankton periodicity and comith only location but by multiple effects of many environments munity structure cannot be explained which control phytoplankton dynamics in the area.

ACKNOWLEDGEMENTS

This work has been fully supported by High Institute of Marine Research at Tischreen University in Lattakia. I am grateful to the anonymous reviewers for their valuable comments.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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