Oceanologia (2015) 57, 61—70

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/oceano

ORIGINAL RESEARCH ARTICLE

Potential effects of abiotic factors on the abundance and distribution of the plankton in the Western Harbour, south-eastern Mediterranean Sea, Egypt

Ahmed M.M. Heneash, Hermine R.Z. Tadrose, Maged M.A. Hussein, Samia K. Hamdona, Nagwa Abdel-Aziz, Samiha M. Gharib *

National Institute of Oceanography and Fisheries (NIOF), Alexandria, Egypt

Received 5 September 2014; accepted 19 September 2014
Available online 25 October 2014

KEYWORDS
Phytoplankton;
Zooplankton;
Environmental variables;
Diversity index;
Western Harbour

Summary Samples were collected seasonally from Western Harbour during winter 2012—winter 2013 to examine spatial and temporal variability in phytoplankton and zooplankton abundance in relation to physicochemical parameters. Water was alkaline and well oxygenated. Nutrient concentrations were generally high and related to inflow of discharged waters. A total of 157 and 106 of phytoplankton and zooplankton species were recorded, respectively. The average plankton population was 4×10^6 cells l^{-1} in terms of phytoplankton and 24×10^3 ind. m^{-3} in terms of zooplankton. Seasonal differences in the quantitative and qualitative composition of both communities in the different stations were marked. *Eutreptiella* belonging to class Euglenophyceae overwhelming during spring, reaching an average of 17×10^6 cells l^{-1}. The genus previously was recorded as rare form in the Egyptian waters and may have been introduced via ballast water. Except in spring, copepods were the most abundant group and tintinnid abundances generally increased in spring. The ranges of Shannon diversity indices indicate disturbance level and sometimes high productivity. Salinity, dissolved oxygen and pH may be responsible for the variations in phytoplankton and zooplankton community structure. The results indicate that not only the discharged water make the harbour at risk, but also the ballast water is not less dangerous, and so, we emphasize the need for activation of the ballast water management IMO Ballast Water Management Conventions to reduce the risk of future species invasions.

* Corresponding author at: Alexandria, 21556, Egypt. Fax: +20 034801443.
E-mail address: gharibsamiha@hotmail.com (S.M. Gharib).
Peer review under the responsibility of Institute of Oceanology of the Polish Academy of Sciences.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.oceano.2014.09.003
0078-3234/

1. Introduction

Egypt's Mediterranean coastline occupies the south-eastern corner of the Mediterranean. The coastal zone of Egypt is of great economic and environmental significance, and it combines localities of intensive socio-economic activities and urbanized areas. The Mediterranean Sea has many ports open for international shipping. The Western Harbour (WH) is the first Egyptian harbour and used for commercial shipping, serving about three quarters of Egypt's international trade. It is the most polluted spot in the Egyptian northern coast (Shriadah and Tayel, 1992; Tadros and Nessim, 1988). The harbour is subjected to multiple sources of pollutant interacting in proper combination leading to the development and persistence of nuisance algal blooms and having also a severe effect on the water quality and the associated aquatic ecosystem (Saad et al., 1993).

Elevated inputs of nutrients can produce eutrophication (Newton et al., 2003) with its associated problems, such as harmful algal blooms (HABs) and deterioration of water quality (Domingues et al., 2011). It also must be taken into account that ships facilitate the transfer of aquatic organisms across natural boundaries (Gollasch, 2002) when the ballast water discharged, and the non-indigenous species are released at the port of destination, and they may become established in the recipient ecosystem and spread (Kolar and Lodge, 2001). These invasive species can pose a risk to biodiversity (McGeoch et al., 2010) and, in some cases, also to human health (Ruiz et al., 2000).

Numerous studies have been carried out on the physical, chemical (Farag, 1982; Shriadah and Tayel, 1992; Saad et al., 2003) and biological characteristics of the WH. (Abdel-Aziz, 2002; Dorgham et al., 2004; Gharib and Dorgham, 2006; Nessim and Zaghloul, 1991; Zaghloul, 1994, 1996).

The main objectives of this study were to analyze the variations in the phytoplankton, zooplankton communities as a response to physical and chemical water variables during the different seasons and to understand which species could be used as indicators of HABs.

2. Material and methods

2.1. Study area

The WH is approximately a closed elliptical shallow basin with an area of 7.4 km^2 and depth range of 5.5—16 m, connected to the sea through a small opening of less than 100 m width at its southwestern side. Inside the harbour, there are several small basins delivered for different maritime activities. The harbour receives directly freshwater from Noubaria Canal at its southern part and indirectly waste waters from Umoum Drain at its western side (Fig. 1) (Dorgham et al., 2004).

2.2. Methods

Study at eleven stations was carried out seasonally from winter 2012 to winter 2013. Specifically, in February 2012, April, September, November and February 2013, these samplings were designated as: winter 2013, spring, summer, autumn and winter 2013 monitoring, respectively. Station 1 was located outside of the harbour, station 2 at the entrance of the harbour to the sea, stations 3 and 4 at the southwestern side, stations 5, 6 and 11 at the heart of the harbour and stations 7, 8, 9 and 10 at the northeastern side of the harbour.

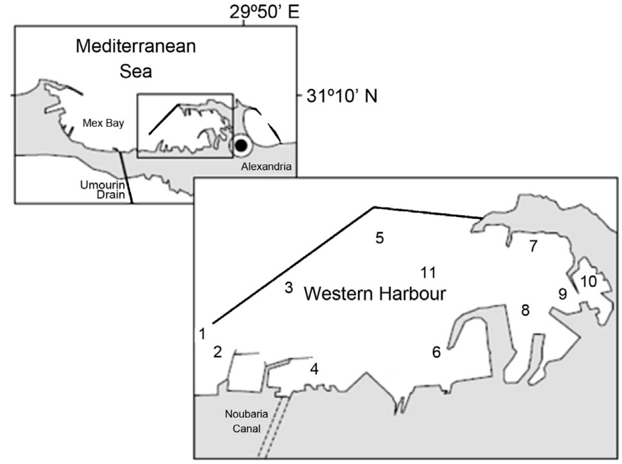

Figure 1 Western Harbour and location of sampling stations.

Samples of hydrological and chemical parameters and phytoplankton were taken seasonally from surface water between winter 2012 and winter 2013, while zooplankton samples were taken for four seasons during the year 2012 and collected with a 55 μm mesh Nansen net (30 cm diameter) by consecutive vertical hauls from near-bottom to the surface at a speed of 0.5 m s^{-1}. Net collections were preserved in 2.5% formaldehyde-seawater solution. Abundances were expressed as the number of individuals per cubic metre (ind. m^{-3}).

Water temperature was measured with a thermometer sensitive to 0.1°C, the pH using a pocket pH meter (model 201/digital pH meter), and the water salinity using a Beckman salinometer (Model NO.R.S.10); dissolved oxygen, dissolved inorganic nitrogen (DIN; nitrate, nitrite, ammonia), soluble reactive phosphorus (SRP) and reactive silicate (RS) were performed according to standard methods described in APHA (1995).

The phytoplankton samples were immediately fixed with 4% formaldehyde for laboratory analysis. Phytoplankton samples were counted and identified using 2-ml settling chambers with a Nikon TS 100 inverted microscope at 400× magnification using Utermöhl's (1958) method, and the zooplankton samples were preserved in 5% neutralized formalin and after settling they were concentrated to 100 ml.

2.3. Statistical analysis

Diversity (H') (Shannon and Wiener, 1963) was used to estimate the community structure for both phytoplankton and zooplankton. The Spearman rank correlation (r) was used to evaluate the relations between environmental variables and both of phytoplankton abundances (N = 54) and zooplankton (N = 43) at each sampling station with the SPSS 8.0 Statistical Package Program.