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FULL LENGTH ARTICLE

Environmental assessment of El-Mex Bay, Southeastern Mediterranean by using Rotifera as a plankton bio-indicator

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Abstract Rotifers are one of the most common, abundant components of plankton in the coastal waters of the Mediterranean Sea, which means that they can be used as bio-indicators and provide useful information on the long-term dynamics of the El-Mex Bay ecosystem. Rotifera species were quantitatively and qualitatively assessed in the El-Mex Bay, west of Alexandria at eight stations to study spatial, temporal, dominance, and abundance of the rotifer community and their relation with changes in environmental conditions. Samples were collected seasonally from autumn 2011 to autumn 2012. Ecological parameters were determined and correlated with total rotifers abundance to gain information about the forces that structure the rotifer community in this dynamic environment. A total of 38 rotifer species were identified belonging to 16 genera within 12 families and 3 orders under one class and contributed about 12.1% of the total zooplankton in the study area with an average of 1077 specimens/m^3. Maximum density was observed in summer 2012 with an average of 1445 specimens/m^3. During autumn 2011 rotifers appeared in low density (434 specimens/m^3). The predominant species *Ascomorpha saltans*, *Brachionus urceolaris*, *Synchaeta oblonga*, *Synchaeta okai*, *Synchaeta pectinata* and *Synchaeta tremula* were recorded in all study stations of the bay. Salinity, temperature, depth, and chlorophyll-*a* concentration were the most important environmental factors co-related with the abundance of rotifers in the El-Mex Bay. A significant positive

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correlation between the total rotifer abundance and chlorophyll-*a* was observed during winter 2012 and summer 2012 ($r = 0.763$ and $r = 0.694$, respectively, at $p \leqslant 0.05$).

Introduction

Zooplankton species succession and spatial distribution result from differences in ecological tolerance to abiotic and biotic environmental factors (Marneffe et al., 1998). According to Rocha et al. (1997), to understand such changes and its impact on natural systems, some knowledge of the structure of the community and of the main processes involved in nutrient cycling and production is required.

Rotifers are important components of planktonic communities because of their rapid heterogenetic reproduction. They are the first metazooplankters to cause an impact by grazing on the phytoplankton. Furthermore, rotifers influence various interactions within the microbial food-web which occurs at several trophic levels (Arndt, 1993). Rotifers are microscopic herbivores, common in the plankton of freshwater habitats, which feed on single-celled algae and bacteria. Where food is abundant, they may exceed 5000 per liter of water (Wallace and Snell, 1991). Their abundance reflects eutrophication; for example, *Keratella cochlearis* and *Kellicottia quadrata* increase with an enhanced input of phosphorous (Edmondson and Litt, 1982).

In Egypt, after the construction of the Aswan High Dam and controlling of the Nile River water flow, the El-Umoum Drain became one of the main land based sources regularly discharging its waters directly to the Mediterranean sea at the El Mex Bay, west of Alexandria. Due to the domestic and industrial waste effluents discharging, the drain water is slightly brackish, does not exceed 5 psu, with dissolved oxygen ranging between 0.5 and 3.58 ml l^{-1}. Nutrient salts showed high levels up to 28, 346, 42 and 22 μM for phosphate, silicate, ammonia and nitrites, respectively; pH values fluctuated between 7.25 and 7.93 (Hossam and Petras, 1998; El-Rayis and Abdallah, 2006; Nessim et al., 2005, 2010; Hendy, 2013). The water characteristics, phytoplankton and zooplankton population of the El-Mex Bay and the El-Umoum Drain were previously studied (Soliman and Gharib, 1998; Gharib, 1998; El-Sherif, 2006; Hussein and Gharib, 2012) and showed that, the continuous discharge of polluted water into the bay caused massive development of algal blooms and a gradual deterioration of water quality. Also, (Zakaria et al., 2007) illustrate the influence of salinity variations on the abundance and community structure of zooplankton in the El-Mex Bay waters.

In this paper, we first describe the study, the material and the techniques used to collect the biological and physical data and after that, we show the correlations between the physico-chemical parameters, water temperature, salinity, and chlorophyll-*a* concentration. Moreover, we analyze the Rotifera community and the variability of the main groups observed in relation to the environmental variables and the hydrograph of the studied area is established. Finally, we notify the dramatic consequences that might be observed on rotifers species in the El-Mex Bay.

Material and methods

Area description

El-Mex Bay is bordering an industrial zone located west of Alexandria City, one of the most densely populated cities in Egypt with 6 million people (Fig. 1). This bay extends about 7 km between longitudes 29° 45′ and 29° 54′ E and latitudes 31° 07′ and 31° 15′ N, from the Agami headland (west) to the Western Harbor (east) and occupies an area of 19.4 km^2, with a mean depth of 10 m and a water volume of 190.3×106 m^3.

As a consequence of growing heavy industries (chloro-alkali, cement, chemicals, textile, tanneries, industrial dyes, ink, petroleum refining, meat processing, fish production, and iron or steel industries) and the uncontrolled disposal of resulting wastes, the coastal waters of the El-Mex Bay receive huge amounts of untreated industrial wastes dumped directly into the southern part of the bay via pipelines. In addition, El-Dekhaila Harbor has been recently constructed at the western side of the El-Mex Bay.

The bay receives about 2.547×10^9 m^3 y^{-1} of agricultural wastes mixed with water effluents (surplus water) from a neighboring sewage-polluted lake (Lake Mariut) with a rate of 262.8×10^6 m^3 y^{-1} via the Omoum Drain. In addition, the bay receives 13×10^6 m^3 y^{-1} of industrial discharge, as well as water from the Western Harbor amounting to 1.13×106 m^3 y^{-1}. The residence time of the El-Mex Bay water was found to be around 28 days. Accordingly, this bay is considered as an estuarine zone of the huge agricultural Omoum Drain (Halim et al., 1995).

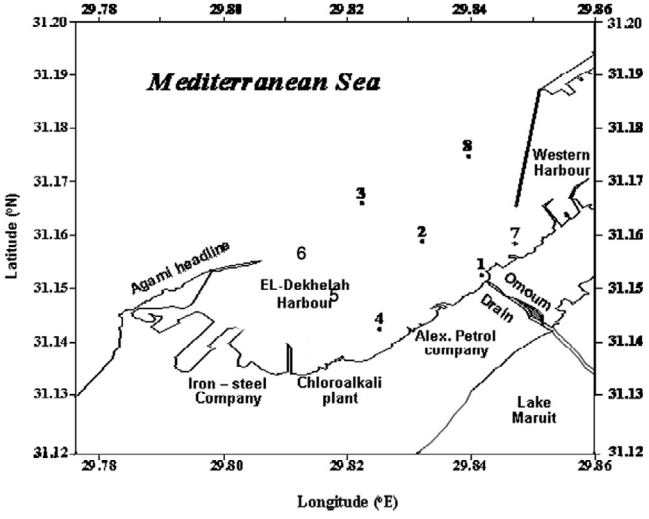

Figure 1 The location of stations in the El-Mex Bay.