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ORIGINAL ARTICLE

Population fluctuation and vertical distribution of meiofauna in the Red Sea interstitial environment

Hamed A. El-Serehy [a,b,*], Fahad A. Al-Misned [a], Khaled A. Al-Rasheid [a]

[a] Department of Zoology, College of Sciences, King Saud University, P.O. Box 2455, Riyadh 11451, Saudi Arabia
[b] Department of Marine Science, Faculty of Science, Port Said University, Egypt

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Abstract The composition and distribution of the benthic meiofauna assemblages of the Egyptian coasts along the Red Sea are described in relation to abiotic variables. Sediment samples were collected seasonally from three stations chosen along the Red Sea to observe the meiofaunal community structure, its temporal distribution and vertical fluctuation in relation to environmental conditions of the Red Sea marine ecosystem. The temperature, salinity, pH, dissolved oxygen, and redox potential were measured at the time of collection. The water content of the sediments, total organic matters and chlorophyll *a* values were determined, and sediment samples were subjected to granulometric analysis. A total of 10 meiofauna taxa were identified, with the meiofauna being primarily represented by nematodes (on annual average from 42% to 84%), harpacticoids, polycheates and ostracodes; and the meiofauna abundances ranging from 41 to 167 ind./10 cm^2. The meiofaunal population density fluctuated seasonally with a peak of 192.52 ind./10 cm^2 during summer at station II. The vertical zonation in the distribution of meiofaunal community was significantly correlated with interstitial water, chlorophyll *a* and total organic matter values. The present study indicates the existence of the well diversified meiofaunal group which can serve as food for higher trophic levels in the Red Sea interstitial environment.

1. Introduction

The increased interest of the biologists in studying benthic meiofauna started in the early 1980s. Its small size, together with difficulties in isolating the meiofauna from the sediments and the identification of species belonging to different taxa are probably the main obstacles of studying the benthic meiofauna (Austen et al., 1994; Harguinteguy et al., 2012). Meiofaunal organisms play an important ecological role in the aquatic ecosystem and are well suited for environmental impact assessment studies. They have short generation times, continuous reproduction, and in situ direct development, and therefore,

* Corresponding author at: Department of Zoology, College of Sciences, King Saud University, P.O. Box 2455, Riyadh 11451, Saudi Arabia. Tel.: +966 11 4675753; fax: +966 11 4678514.
E-mail address: helserehy@ksu.edu.sa (H.A. El-Serehy).
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their potential for rapid response to environmental changes is high (Fraschetti et al., 2006; Giere, 1993; Gyedu-Ababio and Baird, 2006; Harguinteguy et al., 2012). The marine meiofauna is often a very useful tool for biological monitoring since the community structure may be sensitive to both natural and anthropogenic environmental disturbances (Gyedu-Ababio and Baird, 2006; Mirto and Danovaro, 2004; Moreno et al., 2008; Harguinteguy et al., 2012). Moreover, the beeches may function as natural filters responsible for the remineralization of substances, which then return to the sea as nutrients (Coull and Chandler, 2001). The interstitial system of the beaches, in particular the system protected by muddy sediments, is formed by long and intricate food chains of bacteria, unicellular algae and meiofauna at the first levels. Therefore, biological systems are dependent on the productivity of coastal areas (Higgins and Thiel, 1988; Leguerrier et al., 2003).

The growth and diversity of meiofauna may be stimulated by feeding on bacteria, which could increase the recycling of nutrients into the ecosystem and thereby be expected to have a greater productivity (De Wit et al., 2001; De Troch et al., 2006). Moreover, the meiofauna can provide food for higher trophic levels, such as fish and marine invertebrates (Leduc and Probert, 2009). The spatial patterns of the structure of the meiofaunal community in sandy beaches of marine ecosystems may be associated with different environmental variables. Related to this, the sediment granulometry (Gómez Noguera and Hendrickx, 1997; Barnes et al., 2008), the organic matter source in coastal sediments (Danovaro et al., 2002; Flach et al., 2002; Moreno et al., 2008; Ingels et al., 2009; Pusceddu et al., 2009), and oxic and anoxic conditions in the interstitial pore space (Mirto et al., 2000; Sutherland et al., 2007) have a fundamental role in the richness and abundance of the benthic meiofauna.

The criteria in the study of benthic meiofauna were established by Giere (1993) and these concepts have been recently applied for the Egyptian fauna of the Red Sea (Hanafy et al., 2011; Ahmed et al., 2011). However, none of the two studies took place on the vertical distribution of the meiofauna. This somewhat meager data suggest that there is a need for more information on meiofaunal community of the Egyptian coasts along the Red Sea and their temporal changes, weather stochastic, seasonal or long term to understand their trophic relation in the benthic ecosystem. This pioneer study was undertaken to provide answers to the basic question on what are different types of meiofaunal metazoans and their spatio-temporal variation in the Egyptian coasts of the Red Sea.

2. Materials and methods

Sediment samples for environmental parameters and meiofauna were collected from three stations of Gabal El-Zeit (site I), Safaga (site II) and Al-Qulaan (site III) (Fig. 1); with the help of a hand core of 4.5 cm inner diameter and 10 cm length situated approximately 350 m apart in the sea. The three stations were selected based on their proximity to mangrove. Safaga (lat 26° 36′ 56″N, long 34° 00′ 43″E) and Al-Qulaan (lat 24° 21′ 28″N, long 35° 18′ 23″E) were closer to mangrove vegetation than Gabal El-Zeit (27° 48′ 10″N, long 33° 33′ 59″E). Samples for horizontal and vertical distribution were collected seasonally during 2012. Sampling was carried out where three replicate cores were collected at low tide by inserting the 10 cm length core into the sediment from each station. The core sediments were sub-sectioned at 2 cm interval for the study of vertical distribution of meiofauna, grain size analysis, and total organic matters. The percentage of silt/clay in the sediment was obtained by wet sieving using a 62 μm sieve to separate the fine and sand fractions, which were then dried at 80 °C and weighed (Harguinteguy et al., 2012).

Sediment samples containing meiofauna were preserved in 4% formalin and stained with Rose Bengal (Ansari et al., 2001). In the laboratory, these samples were elutriated of larger sand particles using a shake and decant procedure (Cross and Curran, 2000) and meiofauna were sorted by sieving through 0.50 and 0.062 mm mesh sizes sieves. The content of the 0.062 mm sieve was recovered and preserved in the fixative (Ditlevsen, 1911). Then, the fauna were identified to higher taxa and counted under a stereomicroscope (Higgins and Thiel, 1988), and dry weight biomass was obtained by multiplying a factor of 0.00045 with total number of taxa recorded on each sampling date and station (Ansari, 1989). The meiofaunal density was standardized to individuals per 10 cm^2. Identification of meiobenthic organisms were performed using the keys of Riedl (1969), Tarjan (1980), Norenburg (1988), Platt and Warwick (1988) and Huys et al. (1996).

Temperature was recorded with the help of a centigrade thermometer. Interstitial water was collected for the estimation of salinity and dissolved oxygen. For the estimation of salinity, method of Strickland and Parsons (1972) was followed. Oxygen concentration was estimated using an oxygen meter. The percentage of interstitial water of the sediment was measured regularly. Wet sediment from the fraction of core was weighed on a watch glass, dried at 100 °C to constant weight and re-weighed. Wet weight minus dry wet was interpreted as a rough estimate of the weight of the interstitial water from which the percent interstitial water was calculated (Tietjen, 1969). Total organic matters of each sediment sample were determined according to Holme and McIntyre (1984). Sedimentary pigment determination was made according to Tietjen (1968) to obtain estimates of chlorophyll *a* in the sediment.

Simple correlation coefficient (r) was used to find the relation between different environmental parameters and meiofaunal density. Data on meiofauna density obtained in the present study was subjected to the ANOVA analysis to understand whether there exist any significant correlations in the meiofaunal densities with depth.

3. Results

3.1. Physico-chemical conditions

Physico-chemical parameters and sediment characteristics of the three stations are shown in the (Table 1). The seawater temperature was observed to vary from a low of 17.5 °C during winter to 23.7 °C during summer. The variation in water salinity was from 40.6 psu in winter to 44.2 psu during summer. The dissolved oxygen content varied from 4.1 to 5.3 mg/l. The oxygen content showed an inverse relation with temperature and salinity during the present study. Fluctuations in pH around slightly alkaline values were generally limited and