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Invertebrate shells (mollusca, foraminifera) as pollution indicators, Red Sea Coast, Egypt

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ABSTRACT

To assess the degree of pollution and its impact on the environment along the Red Sea Coast, the most abundant nine species of recent benthic foraminifera and three species of molluscan shells have been selected for the analysis of Fe, Mn, Zn, Cu, Pb, Ni, Co, and Cd concentrations. The selected foraminiferal species are: *Textularia agglutinans, Amphispsorus hemprichii, Sorites marginalis, Peneroplis planatus, Borelis schlumbergeri, Amphistegina lessonii, Ammonia beccarii, Operculina gaimairdi*, and *Operculinella cumingii*. The selected molluscan shells are: *Lambis truncata* and *Strombus tricornis* (gastropods) and *Tridacana gigas* (bivalves). The inorganic material analysis of foraminifera and molluscs from the Quseir and Safaga harbors indicates that foraminifera tests include higher concentrations of heavy metals such as Fe and Mn than molluscan shells. These results are supported by the black tests of porcelaneous foraminifera and reflect iron selectivity. The Cd and Pb concentrations in molluscan shells are high in the El Esh Area because of oil pollution at this site. The Cu, Zn, and Ni concentrations in the studied invertebrates are high at Quseir Harbor and in the El Esh Area because of the strong influence of terrigenous materials that are rich in these metals. The heavy metal contamination is mostly attributed to anthropogenic sources.

1. Introduction

Recent invertebrates and protists, especially benthic foraminifera, serve as excellent indicators of the water temperature in past and present environments (Madkour, 2015). Foraminifera and molluscan shells are sensitive organisms for environmental changes. (e.g., Yanko et al., 1994, 1998; Saraswat et al., 2004; Yumun, 2017). Organisms absorb heavy metals; high concentrations of these metals can kill marine organisms and destroy the marine life, especially in coral reefs. The heavy metal concentrations of shells provide a series of natural indicators for the calcification system and principle information on the processes involved (Simkiss, 1983).

The use of recent invertebrates, especially benthic foraminifera and molluscan shells, as bioindicators is less established; however, previous studies proved the ability of benthic foraminifera and molluscan shells to monitor the environmental quality (e.g., Alve, 1995; Armynot du Châtelet et al., 2004; Ferraro et al., 2006; Bouchet et al., 2007; Frontalini et al., 2009; Coccioni et al., 2009; Alve et al., 2009; Armynot du Châtelet et al., 2009; Bouchet et al., 2012; Dolven et al., 2013; Hess et al., 2013).

A growing body of literature focused on assessing the heavy metal contamination in the Red Sea environment using different biological indicators (e.g., Ziko et al., 2001; Madkour, 2004, 2005; Mansour et al., 2005; Madkour and Youssef, 2009; Mohammed and Dar, 2010; El-Taher and Madkour, 2011; Mekawy and Madkour, 2012, 2013; Mohammed et al., 2013; Madkour, 2013, 2015; Youssef, 2015; Youssef and El-Sorogy, 2016).

The major anthropogenic impact at the Egyptian Red Sea Coast is caused by phosphate shipment pollution, oil spills, and the accelerated tourism development. The Quseir and Safaga harbors are the main sources of phosphate shipment pollution in Egypt. The El-Esh Area is subjected to oil pollution because the most important

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sector of the Egyptian oil exploration is in the surroundings of this area. Previous studies generally neglect the usage of recent invertebrates as a tool for Red Sea environment control.

The aim of this study is to assess the degree of pollution in areas subjected to stress and human pressure such as the Quseir and Safaga harbors and the El-Esh Area (Fig. 1). The study includes nine species of the most abundant benthic foraminifera and three species of molluscan shells (gastropods and pelecypods). The present work discusses the environmental impact of heavy metals on recent invertebrates and their application as a tool to monitor hazards.

2. Study area

Quseir Harbor is located in Quseir and is considered one of the old harbors of the Egyptian Red Sea Coast. It is situated at 26°05′02″N–26°06′12″N and 34°16′58″E-34°17′08″E (Fig. 2) in a small bay at the mouth of the Wadi Ambaji. The Wadi Ambaji transported terrigenous sediments to the marine environment. These sediments have a relatively large undercutting effect due to the violent water during heavy torrents. The beach sediments are coarse sands. These coarse sands are significant terrigenous fragments (Fig. 3). The tidal flat is very narrow, extends smoothly, and gently slopes seaward. The sediments covering the bottom topography of this area are fine sand to sandy mud. Most sediment samples have a brown color due to phosphate shipment operations. Marine environment deterioration in the Quseir area includes the spread of algal blooms, dense seagrasses, coral bleaching, declining of the productivity (Fig. 3), and poor biological activity of marine organisms, especially that of coral reefs.

Safaga Harbor is the largest harbor on the Egyptian Red Sea Coast. It is situated at a latitude of 26°43′42″N–26°44′22″N and a longitude of 33°56′20″E- 33°56′05″E (Fig. 2). The intertidal zone is extremely narrow at Safaga Harbor. Shoreward, the area is skirted by high basement mountains. The beach sediments are generally coarse sands mixed with common rock-forming detritus from surrounding formations (Figs. 2 and 3). The sediments covering the intertidal zone are fine to very fine sands that are rich in

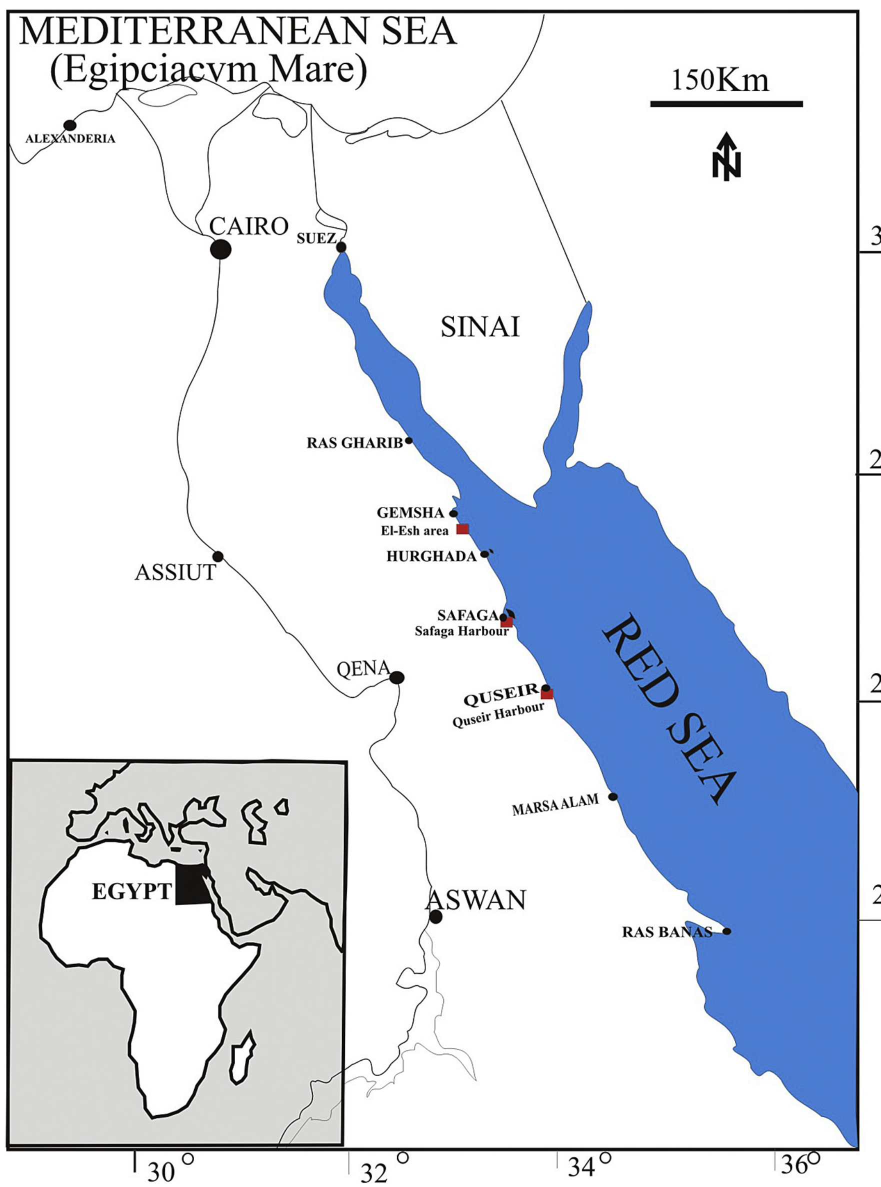

Fig. 1. Location map of the study areas along the Egyptian Red Sea Coast.