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FULL LENGTH ARTICLE

Distribution of heavy metals in seaweeds collected along Marsa-Matrouh beaches, Egyptian Mediterranean Sea

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Abstract The distribution of Cd, Cu, Fe, Ni, Pb, and Zn concentration in two seagrass species in addition to six species of marine macro algae: *Cystoseira sp.*, *Gelidium crinale*, *Laurencia obtusa*, *Gracilaria verrucosa*, *Jania rubens*, and *Enteromorpha compressa* collected along Marsa-Matrouh coastal waters (Egypt) were determined by Flame Atomic Absorption Spectrometry. The recovery study was carried out using a certified reference material NMIJ CRM 7405-a. The obtained heavy metal contents indicated that different species demonstrated various degrees of metal accumulation. In general, El-Boussit station recorded the highest concentrations among the all studied stations. There was a positive correlation between Fe concentrations in the seaweeds and those of Cu and Pb indicated the same source of these metals and/or synergistic interaction between these metals. In general, as regards the influence of the collection sites on the whole metal accumulation, El-Boussit is considered to be the most polluted. There was a positive correlation between Fe concentrations in the seaweeds and those of the Cu and Pb, in addition to negative correlations between Cu and Ni, Pb and Zn. On the basis of the levels of trace elements observed in *Posidonia oceanica* and *Cymodocea nodosa* besides their wide distribution in Marsa-Matrouh beaches; these two species are considered to be good bio-indicators for metals in the area of investigation.

Introduction

Determinations of heavy metal concentrations in aquatic organisms are usually preferred than their measurments in seawater and sediment. The concentration of metals in water is very low and shows wide fluctuations. Metal concentrations in the sediment can be changed by the oxidation–reduction potential, organic content, pH, and the grain size composition (Topcuoglu et al., 2003). On the other hand, seagrass and macro algae can be used as bio-monitors to give information on concentrations of heavy metal or changes in metal availabilities in the surrounding environment, besides their abundance in various environmental systems (Capiomont et al., 2000; Campanella et al., 2001; Ferrat et al., 2003a,b; Topcuoglu et al., 2003). In general, algae are widely distributed in the aquatic environment and are sedentary, easy to collect,

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identify, and the bioaccumulation of trace metals occur in high degrees; satisfying all the fundamental requirements for bioindicators (Campanella et al., 2001; Conti, 2002). In particular, macro algae are recognized to concentrate metals up to levels many times larger than those found in the surrounding waters (Farias et al., 2002; Jones, 1922; Black and Mitchell, 1952). The cell wall of algae consists of a variety of polysaccharides and proteins, some of them containing anionic carboxyl, sulfate, or phosphate groups that are excellent biding sites for metal retention. The binding of metals by macro algae was shown by Bryan, 1969) to be strong, with only a minimal exchange between bound metals and ambient water. Macro algae are able to accumulate trace metals, reaching concentration values that are thousands of times higher than their corresponding concentrations in sea water (Conti and Cecchetti, 2003). Algae bind only free metal ions, the concentrations of which depend on the nature of suspended particulate matter (Seeliger and Edwards, 1977; Luoma, 1983; Volterra and Conti, 2000), which, in turn, are formed by both organic and inorganic complexes.

The Marsa-Matrouh City has an area of 212,112 km^2 and 193,000 inhabitants, or 0.9 inhabitants/km^2 (http://en.wikipedia.org/wiki/Mersa_Matruh, 2014). Marsa-Matrouh is the most important town on the 500 km long stretch of the Mediterranean coast between Alexandria and the Libyan border. In summer, the number of visitors to Marsa-Matrouh increases (more than one million visitors) to enjoy the beautiful white sandy beaches and clear seawater, and hence the human activity in this site increases which reflects the change in the environmental conditions. Little quantitative data are available on the concentration of metals in seaweeds for this area. Little quantitative data are available on the concentration of metals in seaweeds general pollution of this area. In an effort to gain some insight into the level of metal contamination which might exist in the coastal marine environment along the Marsa-Matrouh beaches, the present study reports the concentrations of lead, cadmium, copper, zinc, nickel and iron in two representative species of seagrass in addition to six species of marine macroalgae: *Cystoseira sp*., *Gelidium crinale*, *Laurencia obtusa*, *Gracilaria verrucosa*, *Jania rubens*, and *Enteromorpha compressa*.

Materials and methods

Algae samples were collected during autumn 2009- summer 2010 from ten locations along Marsa-Matrouh beaches as shown in Fig. 1. About 500 g fresh weight, were collected at similar stages of each species at low tide. The samples were washed in seawater at the sampling station, placed in plastic bags and transported to the laboratory in an icebox. At the laboratory, seaweeds were rinsed with seawater to remove sand and epiphyta, washed with distilled water, dried at 80 °C to constant weight in the oven, ground, homogenized and sieved to pass through a 560 μm sieve and kept away from metal contamination (Al-Masri et al., 2003; Topcuoglu et al., 2003).

Five milligrams of dry weight from each sample was put into a Teflon vessel (triplicate times for each sample). The sample is digested by adding 5 ml of concentrated H_2SO_4 and heated on the hot plate for 15 min at 70–80 °C, the sample was left to cool then about 2 ml of nitric acid was added slowly and continued to heat for 30 min. After cooling 15 ml of hydrogen peroxide was added then heated for two hours at 150 °C. Then the solution was diluted to 100 ml with 2% HNO_3 in a volumetric flask (Topcuoglu et al., 2003). The metal concentrations were determined by an atomic absorption spectrophotometer (Spectra AA-10 PlusVarian). Blank samples were performed in the same manner inside each batch of samples. For accuracy and precision of the analytical method, the certificated reference material NMIJ CRM 7405-a: trace elements and arsenic compounds in seaweed (Hijiki)

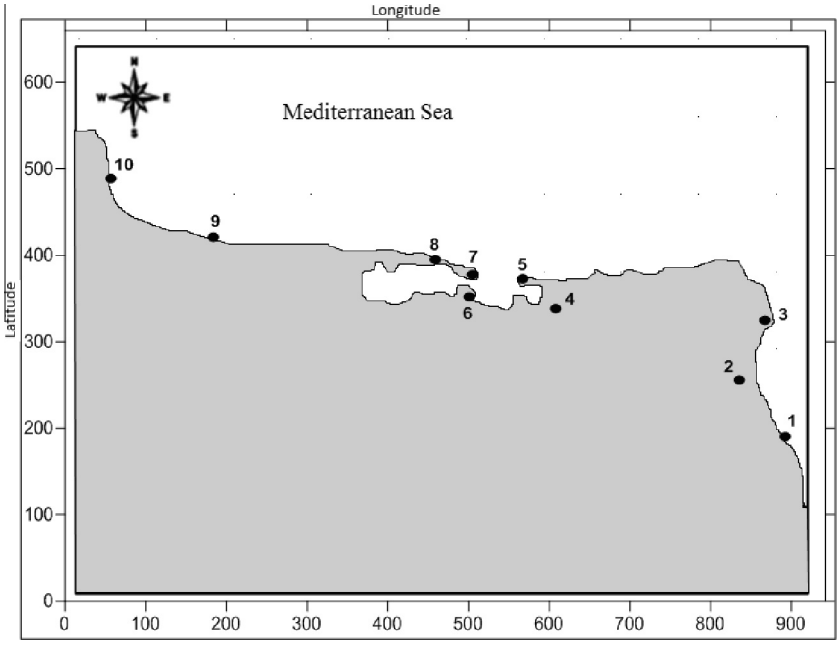

Figure 1 Sampling locations map.