

Benthic foraminifera and heavy metals distribution: A case study from the Naples Harbour (Tyrrhenian Sea, Southern Italy)

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Benthic foraminiferal density and species distribution may be used as pollution indicators.

Abstract

The analysis of 90 surficial sediments from three docks of the Naples Harbour (*Levante*, *Granili*, and *Diaz*) permits to compare the distribution modes of heavy metals with grain sizes, total organic carbon content (TOC) and distribution patterns of benthic foraminifera. Foraminiferal density and species richness decrease with the increasing toxic elements concentrations from the *Levante* to the *Diaz* dock. Median concentrations of Ni, Pb, Zn, and Hg (medians of 21.43 mg/kg, 270.24 mg/kg, 489.65 mg/kg, and 1.18 mg/kg, respectively) were reported for the *Diaz* dock where foraminifera are absent, thus suggesting a possible impact of toxic elements on the benthic ecosystem balance. Compared to the unpolluted marine sediments of the *Granili* dock, the *Levante* area shows higher heavy metals levels and a quasi-oligotypic benthic assemblage. This is dominated by the tolerant species *Ammonia tepida* that may be used as bio-indicator of pollution of anthropised marine sediments.

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1. Introduction

Benthic foraminifera are among the more abundant and most conspicuous protozoa in the coastal environment and, because they have a short life cycle and specific habitats, they tend to respond quickly to changes in their environments and can be used as an early warning indicator (Kramer and Botterweg, 1991) of possible anthropic contamination. Studies of pollution effects on benthic foraminifera and the possible use of these biota as proxies were first proposed by Resing (1960) and Watkins (1961). In the last years, several papers have been devoted to the possibility to correlate distribution, diversity, and population density of benthic foraminifera assemblage with toxic organic and

inorganic compounds distribution (Boltovskoy et al., 1991; Alve, 1995; Yanko et al., 1999; Coccioni, 2000; Scott et al., 2001; Debenay et al., 2001; Bergamin et al., 2003; du Châtelet et al., 2004, and reference therein). Recent studies (Samir and El-Din, 2001; du Châtelet et al., 2004) demonstrated that some benthic species seem extremely sensible to heavy metals and/or organic compounds concentration levels. In particular, some authors (Seiglie, 1975; Setty, 1976; Setty and Nigam, 1984; Yanko and Flexer, 1991; Samir and El-Din, 2001; du Châtelet et al., 2004) suggested that selected benthic foraminifera species (in particular *Ammonia tepida* and some miliolids as *Quinqueloculina seminulum*) seem to better monitor high concentrations of selected toxic elements and/or organic compounds. The main objectives of this work are (i) identification of the distribution modes of the analysed toxic metals relatively to grain size distribution patterns and total organic carbon contents in the studied sediments; (ii) comparison among the

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distribution patterns of the studied heavy metals and the benthic fauna.

2. Material and methods

The harbour of Naples, is located in the eastern Tyrrhenian Sea margin (Gulf of Naples) and is constituted of 11 docks and 30 wharfs that range from 110 to 440 m in length (Fig. 1a). The bottom topography is rather complex and shows a progressive deepening towards the outer part of the harbour (see Fig. 1b). In this study we investigated a total of 90 surface samples from three docks of the Naples Harbour: the *Levante*, *Granili*, and *Diaz* (Fig. 1a). Sediments were collected using a hydraulic vibro-corer

with an inner diameter of 10 cm and 6 m long. Three sub-samples were selected from the surficial 20 cm of sediments, homogenized with a plastic scoop, placed into pre-cleaned Ziploc plastic bags for chemical and paleontological analyses and stored at -18°C on board within an hour of collection.

2.1. Foraminiferal analysis

Each analysed sample was sieved at the $125\ \mu\text{m}$ mesh size. The entire dried residue was microscopically analysed and all the specimens were counted. The foraminifera were hand picked and separated from the sediment. Non-living foraminifera were counted and percentages utilized for statistic analysis. The *Loebelich and Tappan classification* (1988) was used.

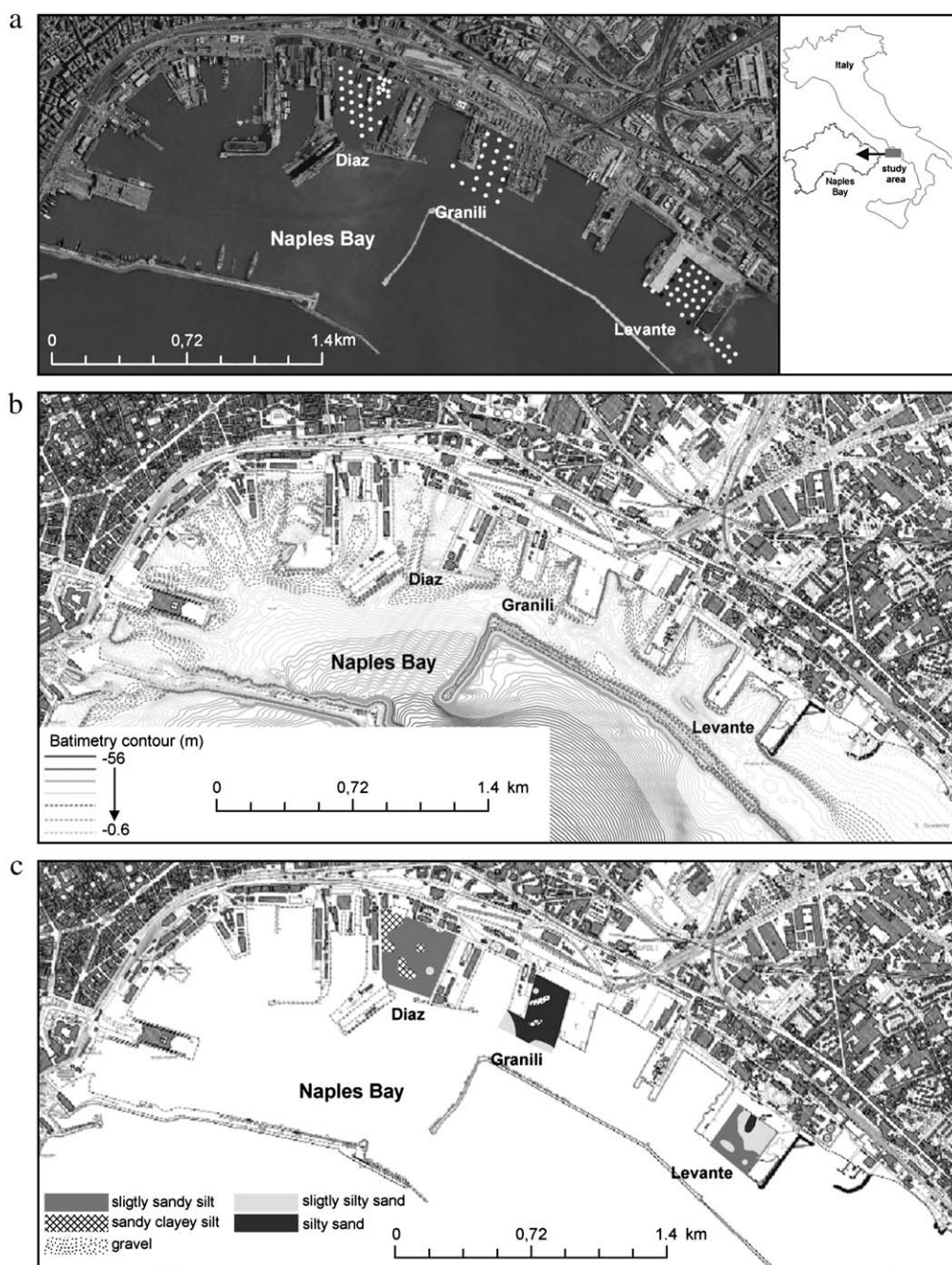


Fig. 1. (a) Location map of the studied docks (*Levante*, *Granili* and *Diaz*) in the harbour of Naples and position of the studied samples (white circle). Black circles in the *Levante* dock show samples where CTD measurements were carried out; (b) topography of the sea floor and (c) grain size of the studied samples.

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