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The influence of seasonality (dry and rainy) on the bioavailability and bioconcentration of metals in an estuarine zone

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ABSTRACT

Knowledge on the concentration of metallic elements is important to certify the quality of ecosystems. Such behaviors in estuarine environments are dependent of factors such as rainfall and temperature of the water, interfering directly on the metal concentrations in biotic and abiotic components. This study observed the role that seasonality (dry and rainy) had on the bioavailability of metals (Fe, Zn, Mn, Cu, Ni, and Al) in surface water and sediment, and bioconcentration in oysters (*Cassostrea rhizophorae*) in the mangrove area of the São Paulo river estuary, Todos os Santos Bay. The metals concentration in three matrices analyzed varied between the periods studied. The values of physicochemical parameters also had significant variations. High levels of Zn and Cu were found in mollusks. The highest concentrations of metals analyzed were Al in waters, Fe in sediments and Zn in mollusks. These results showed that seasonality interferes directly in the physicochemical parameters analyzed (pH, dissolved oxygen, temperature, salinity and Eh), as well as on the bioavailability of metals in both water and sediment, influencing directly on the concentrations found in mollusks.

1. Introduction

The geochemical behavior of metals in estuarine environments can serve as an excellent tool for monitoring the environmental quality of these ecosystems, since the cycling of these elements in mangrove environments is a serious problem that has been widely discussed in the literature (Cundy et al., 2005; Onofre et al., 2007; Reitermajer et al., 2011; Strady et al., 2011). Sediments accumulated over time in these environments become important ecotoxicological markers due to their capacity to accumulate low concentrations of metallic elements that are present in the water. On the other hand, when contaminated, these sediments become a latent source of metals to both the aquatic environment and organisms (Nizoli and Luiz-Silva, 2009).

Due to the fact that estuarine areas are very dynamic, physical and chemical processes which happen in these areas throughout the year influence the geochemistry of metallic elements, changing the behavior and bioavailability of metals in the water, sediment and also in organisms in different seasons of the year (Campana et al., 2005; Vincente-Martorell et al., 2009). In the area where the study was conducted, no parameters have been related to seasonal variation, only studies carried out during specific seasons of the year have been performed, but without emphasizing annual variations which can influence the geochemistry of metals.

The use of biomonitoring species to respond to possible cases of environmental contamination is essentially relevant in estuarine areas (Silva et al., 2006). Bivalve mollusks have been widely used in various environmental studies regarding qualification and quantification of contaminants (Ruelas-Inzunza and Páez-Osuna, 2000). These organisms are considered good bioindicators that have significantly contributed to the interpretation of results in various studies in the field of environmental investigations as well as the bioavailability of metallic elements (Páez-Osuna et al., 1995; Silva et al., 2006). The present study used the species *Cassostrea rhizophorae*, popularly known as the mangrove oyster, as an indicator organism for the presence and quantification of metals in the area studied. These are invertebrate, sessile and filter-feeder organisms

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that usually accumulate pollutants in their tissue. They are also easily sampled, are of reasonable size, sedentary and have a long life span, which makes these animals excellent bioindicators and/or biomonitors (Silva et al., 2006).

Some metallic elements are of extreme importance for the maintenance of favorable conditions in the mangrove environment (Pekey et al., 2004). Metals are found in low concentrations in this kind of environment and are considered to be essential nutrients for the biota and human development (Hooda, 2010). Meanwhile, these same elements in high concentrations can cause problems to the organisms present in the region (Lacerda et al., 1993; Costa, 2007).

Metals may be available through the water column (dissolved or suspended) or associated with the sediment, which becomes a major polluting fixative (Cundy et al., 2005; Lacerda and Molisani, 2006). When available in the aquatic environment, some organisms can assimilate these metals, such as mollusks that feed through a filtration process, setting those elements in their metabolism (Strady et al., 2011).

It is important to emphasize that some diagenetic processes determined by pH, redox conditions, organic matter content and particle size can interfere in the concentration and distribution of metallic elements along an estuary (Alagarsamy, 2006; Du Laing et al., 2008; Reitermajer et al., 2011). These factors are directly influenced by rainfall, so seasonal studies (dry and rainy seasons) are important in this kind of assessment (Nizoli and Luiz-Silva, 2009).

Understanding the behavior of metals associated with the sediment according to their characteristics and, essentiality, in relation to the organisms is highly relevant. An important way to study these elements is evaluating their bioavailability and bioconcentration in the environment they are located. Considering these topics, we can have a quality assessment of the environment being studied, since this approach allows the investigation of an array of systems, such as the sediment, surface water and biological material, reflecting, with a good degree of reliability, the environmental conditions assessed (Vincente-Martorell et al., 2009).

The aim of the present study was to investigate the seasonal (dry and rainy seasons) bioavailability and bioconcentration of six metals (Zn, Mn, Cu, Fe, Ni, and Al), in the sediment, surface water and bivalve mollusks in the São Paulo river estuarine system, Todos os Santos Bay, Bahia, Brazil.

This area is used as a place of gathering seafood and fishing, that native people can use these resources as a commercial activity and for their own feeding. Therefore, this research has an important aspect to understand the dynamics of metals and check for possible levels of contamination.

2. Materials and methods

2.1. Studied area

This study was carried out in the São Paulo river estuary, a river that has its outlet in the Todos os Santos Bay, within the coordinates of 38° 35′ 0″ to 38° 30′ 30″ W and 12° 45′ 0″ to 12° 41′ 0″ S (Fig. 1).

The São Paulo river estuary, located in the Todos os Santos Bay, where a magnificent mangrove ecosystem develops, has a fundamental importance to the local food chain and to the livelihood of many of the inhabitants of the region. This estuarine ecosystem has been affected by many human activities, such as contamination by chemical industries, which have contributed to the deterioration of the estuary (Carvalho, 2007).

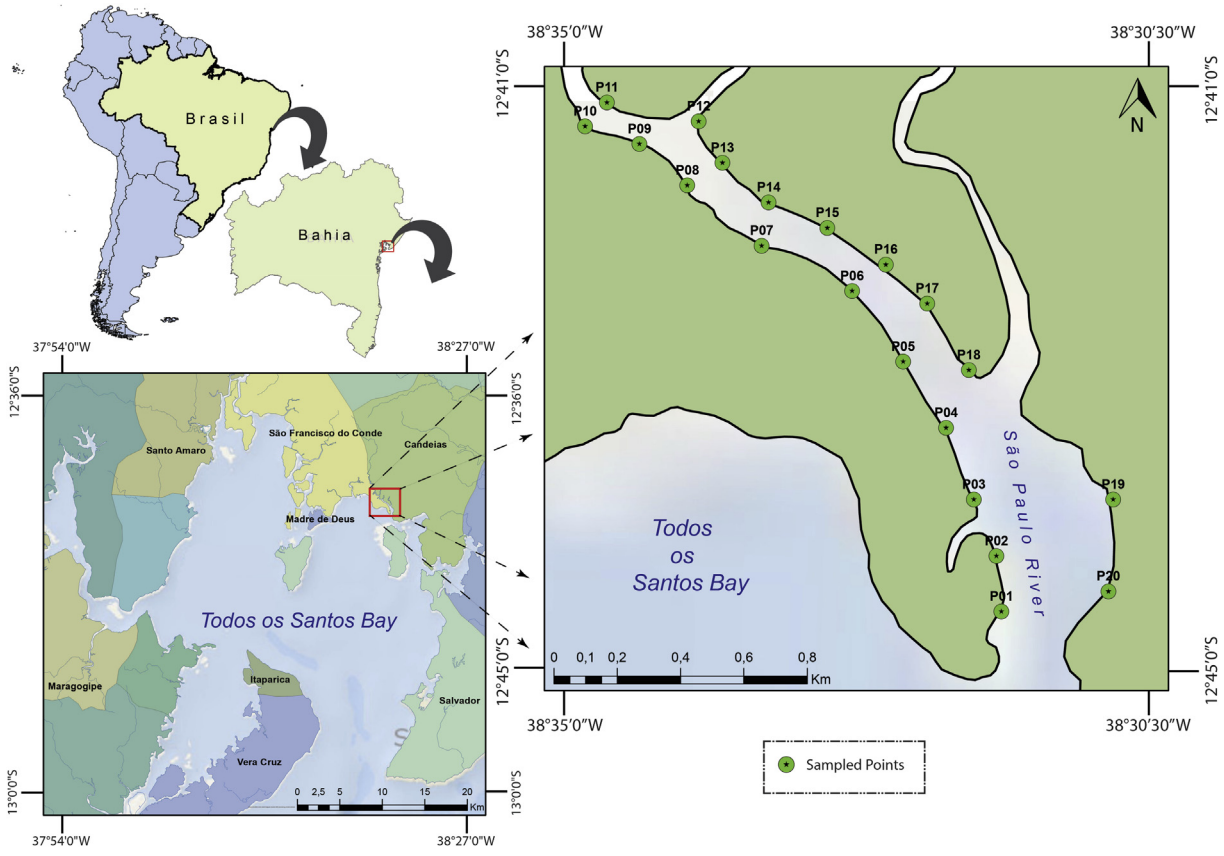

Fig. 1. Map of the studied area and sampling points.