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Field validation of autometallographical black silver deposit (BSD) extent in three bivalve species from the Lagoon of Venice, Italy (*Mytilus galloprovincialis*, *Tapes philippinarum*, *Scapharca inaequivalvis*) for metal bioavailability assessment

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Abstract

The autometallographic approach was applied to three filter-feeder bivalves from differently polluted sites of the Lagoon of Venice. The area density (AD) values of black silver deposits (BSDs) were therefore seasonally quantified by image analysis in digestive cell lysosomes. Sediments were characterised in terms of grain size, organic content and metal concentrations (Cd, Cu, Ni, Pb, Zn). The physiological status of the bivalves was also evaluated by applying the "survival in air" test as a generic stress index. Chemical results showed that Zn contributed to the total metal load for more than 60% in sediments and for 85%–94% in mussel and clam digestive glands, respectively (data processed from published results obtained on the same samples). Regression analyses between extent of BSDs and both total metal and Zn concentrations in digestive gland followed a linear pattern in mussels and clams, but not in arks. Similarly, in mussels and clams only, BSD amount was significantly correlated with total metal concentrations in sediments according to a logarithmic model. Consequently, results obtained from autometallography can discriminate sites on the basis of their metal pollution levels, like chemical analyses on both sediments and digestive glands, evaluations being supported by the results of the physiological stress index. As a conclusion, it is suggested that autometallography in bivalves may provide overall estimates of metal fractions moving from sediments towards organisms through the ingestion of metal-enriched particles.

Future work is needed to define the bioaccumulation model in arks and to clarify their possible use as metal biomonitors.

Keywords: Autometallography; Bivalves; Sediment pollution; Trace metal; Lagoon of Venice

1. Introduction

Monitoring heavy metals is of great concern in many marine coastal environments where pollution occurs as a result of human activities. In the last few decades, a huge number of studies from all over the world have focused on evaluation of contamination levels in sediments and in the water column (Cutter, 1991; Bryan and Langston,

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1992; Prego and Cobelo-García, 2003). However, only by the increasing use of biomonitors, as introduced in the 1970s by "the mussel watch" biomonitoring programmes (Goldberg et al., 1978), has the knowledge on the bioavailability of metals, their fate and effects on biota been greatly improved. This approach is essential for assessment of potential ecotoxicological risks to aquatic organisms and, ultimately, to humans. Although chemical methods, such as atomic absorption spectrophotometry, are largely employed to evaluate metal levels in both abiotic and biotic compartments, their application still suffers from problematic aspects, mainly concerning biological and physico-chemical factors variously affecting estimates of metals in soft tissues (Phillips, 1980; Fischer, 1983, 1986; Mason and Simkiss, 1983; Depledge and Rainbow, 1990). Recently, several alternative methods, based on a microscopic approach, have been proposed as technically simpler and cost-effective tools to assess metal contents in biological samples, mostly from molluscs (Marigómez et al., 2002). In addition, they give greater insight into the mechanisms of metal toxicity, by providing information about the cellular and subcellular localisation of metals and elucidating the cellular response to toxic metal uptake (Herwig et al., 1989; Raftopoulou et al., 2002; Soto et al., 2002). Among these methods, autometallography is a no-specific histochemical procedure for detecting metal ions in biological sections (Danscher, 1984, 1991; Danscher and Montagnese, 1994; Danscher et al., 1987). It applies silver amplification of metal ions, which are detected as black silver deposits (BSDs), basically on the principles of photography, under light or electron microscope (Danscher, 1981; Danscher and Moller-Madsen, 1985). Laboratory studies have demonstrated that BSD

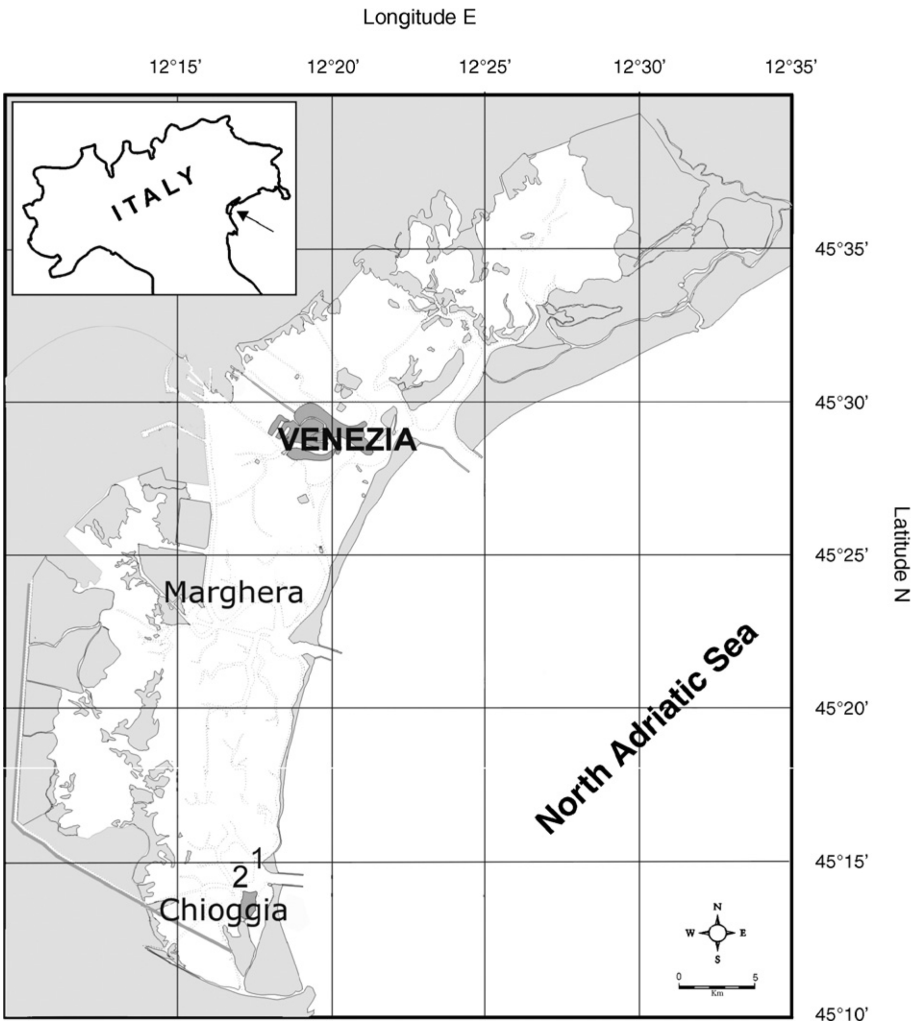

Fig. 1. Sampling sites in Lagoon of Venice (Italy).