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Effects of heavy metals on sea urchin embryo development. Part 2. Interactive toxic effects of heavy metals in synthetic mine effluents

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Abstract

Interactive toxic effects between heavy metals were investigated using a sea urchin (*Anthocidaris crassispina*) bioassay. An effluent from an abandoned mine showed significant inhibitory effects on embryo development as well as producing specific malformations. The effects on the embryos were reproduced by synthetic polluted seawater consisting of eight metals (manganese, lead, cadmium, nickel, zinc, chromium, iron, and copper) at the concentrations detected in the mine effluent. This indicated that the heavy metals were responsible for the effects observed. Five heavy metals were ranked in decreasing order of toxicity as follows: Cu > Zn > Pb > Fe > Mn. Among these, zinc and manganese could cause malformation of the embryos. From bioassay results using 27 combinations of heavy metals, 16 combinations including zinc could produce specific malformations, such as radialized, exo-gastrulal, and spaceship Apollo-like gastrulal embryos. Zinc was one of the elements responsible for causing malformations and its effects were intensified by the presence of the other metals, such as manganese, lead, iron, and copper.
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Keywords: Bioassay; Disused mine; Malformation; Sublethal toxicity; Synthetic effluent

1. Introduction

The toxicity of the polluted waters originating from a disused lead mine was evaluated in our previous study (Kobayashi and Okamura, 2004) using both sea urchin bioassay and heavy metal analysis. The test waters, containing high concentrations of eight heavy metals (manganese, lead, cadmium, nickel, zinc, chromium, iron, and copper), had inhibitory effects on the development of sea urchin embryos at a 1/50 dilution of the raw water. The test water induced various malformations, such as radialized pluteus, exo-gastrula, and spaceship Apollo-like embryos. It was speculated that zinc was one of the metals causing malformations and that interactive effects occurred involving zinc and other metals. Interactive effects between metals can result in synergistic, additive or antagonistic actions and these effects have been reported following bioassays using sea urchin (Kobayashi and Fujinaga, 1976; Warnau et al., 1998;

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