

# The effect of the heavy metals lead (Pb<sup>2+</sup>) and zinc (Zn<sup>2+</sup>) on the brood and larval development of the burrowing crustacean, *Callianassa kraussi*

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## Abstract

This investigation explored the effect of the heavy metals Pb (Pb<sup>2+</sup>) and Zn (Zn<sup>2+</sup>) individually and in combination (i.e. three metal solutions) on both the brood and larval development of the burrowing crustacean, *Callianassa kraussi*. Egg and larval mortalities at factorial (4x7) combinations of salinity (20, 24, 30, 35 mg/ℓ) and seven respective metal concentrations were examined. The results provided various statistically significant trends. Individual concentrations of Pb and Zn at various salinities impacted negatively upon the brood and larval development of *Callianassa kraussi*. Increasing the specific concentrations of both metals further demonstrated a negative influence, especially on brood development and to a lesser extent on larval development of *Callianassa kraussi*. Comparing the toxicity of the three concentrations of metals to *Callianassa kraussi* brood and larval development, it was found that individual Pb concentrations exhibited the least mortality (LC<sub>50</sub> Pb-eggs-35ppm = 1.580 mg·ℓ<sup>-1</sup> whilst individual Zn concentrations displayed considerably higher mortality (LC<sub>50</sub> Zn-eggs-35ppm = 0.066 mg/ℓ) but that the combination of Zn and Pb concentrations produced the highest mortality (LC<sub>50</sub> Pb&Zn-eggs-35ppm = 0.036 mg·ℓ<sup>-1</sup>). Varying salinities in permutation with varying metal concentrations exhibited a significant detrimental influence on the brood and larval development of *Callianassa kraussi*, notably at the lowest salinities in combination with the highest metal concentrations.

**Keywords:** heavy metals, Pb, Zn, mortality, toxicity, brood and egg development, estuarine environment, *Callianassa kraussi*, sediment, sand prawn

## Introduction

Although human activities have always impacted on coastal areas, it is only within the last two centuries that the effects of industrialization, intensive agriculture and coastal engineering (including tourism) have seriously begun to threaten marine life (His et al., 1999). Most of these impacts have led to environmental pollution, i.e. the introduction of substances or energy by man into the environment, which may put living resources and human health at risk. Forstner and Wittmann (1981) stated that compared with land systems, the relatively small biomass in aquatic environments generally occurs at a greater variety of trophic levels. This correlates to the particular sensitivity of aquatic systems with regard to pollution influences. Unfortunately, this distinctive trophic structure enhances accumulation of xenobiotic and poisonous substances.

Clark (1989) maintained that the problem is further extrapolated in the sense that rivers carry their pollutants (either in dissolved, colloidal or particulate form) to estuaries and finally to coastal oceans, where harmful substances enter the food chain and become concentrated in fish and other edible organisms (known as bioaccumulation), particularly in near-shore areas (His et al., 1999).

Many substances pollute the marine environment, but non-biodegradable compounds are the most dangerous due to their innate ability to constantly remain with the ecosystem (Hernandez-Hernandez et al., 1990; Tyler, 1972). Heavy metals are notable for

their high toxicity, as are organochlorine compounds such as pesticides and PCBs, amongst others. According to Van Vuuren et al. (1999), metal pollutants are currently considered to be some of the most toxic contaminants present world-wide. Furthermore, Carvalho et al. (1999) states that heavy metals are some of the most toxic, persistent, and widespread contaminants in estuarine systems in the sense that dissolved or suspended metals become available to plankton, nekton, and benthic filter and deposit feeders. The release of metal ions into a river system poses a serious threat to aquatic life and causes secondary effects upon the water quality. According to Robinson and Avenant-Oldewage (1997) the two factors which contribute principally to the damaging effect of metals as environmental pollutants are, firstly, their inadequate biological degradation to inert metals (as in the case of most organic pollutants), and secondly, the trend of metals to accumulate and largely remain in the aquatic environment. Some heavy metals in trace concentrations are normal constituents of marine organisms, but are potentially toxic at elevated concentrations (Ober et al., 1987). Metal pollution has become a major international issue since the 1960s when thousands of people were poisoned in Minamata, Japan, after consuming mercury –polluted fish (Fergusson, 1990).

Ober et al. (1987) and the WRC (1999) affirmed that pollution of the marine ecosystem by heavy metals is a world-wide problem, and the main sources of metal pollution are domestic/industrial sewage, industrial effluents, oil and chemical spills, combustion emissions, mining operations, metallurgical activities and non-hazardous landfill sites. According to Hernandez-Hernandez et al. (1990) the presence of metals in the marine environment is partly due to natural processes such as volcanic activity and erosion, but mostly results from industrial processes, with metals mainly

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