ABSTRACT

LETHAL AND SUB-LETHAL EFFECTS OF SINGLE AND COMBINED EXPOSURE TO HEAVY METALS DURING THE LIFE CYCLE OF THE TROPICAL MYSID, *METAMYSIDOPSIS INSULARIS*

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The tropical mysid, *Metamysidopsis insularis*, is the proposed standard test species for marine and estuarine areas of Trinidad and Tobago. In order to assess its sensitivity to heavy metal exposure, various life stages were subjected to lethal and sub-lethal concentrations of heavy metals when reared from newly released juveniles to adults. Early juvenile mysids were exposed to lethal concentrations of copper, cadmium, chromium, nickel and arsenic for 96 hours. Acute toxicity increased in the order of Cr<Ni<Cu<Cd<As. Newly released mysids were exposed to single, sub-lethal concentrations of copper, cadmium (exposure range: 0.002 – 0.04 mg/L) and nickel (exposure range: 0.01 – 0.3 mg/L) for a complete life cycle. The weight-specific oxygen consumption and ammonia excretion rates of *Metamysidopsis insularis* were significantly influenced by the concentration of copper and cadmium as well as life stage. These rates were particularly depressed in the early juvenile stages but were not affected as the organisms developed to adults. The sub-lethal concentrations of nickel used were too low to produce any effects on either the oxygen consumption or ammonia excretion rates of the mysid. Exposure to nickel at 0.1 and 0.3 mg/L resulted in an increase in growth rate as seen by increases in body weight in the early adult and adult life stages.

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From single exposure studies, it was determined that at specific exposure concentrations, respiration rate was depressed only in the early juvenile stages. There were concentrations at which no changes were observed in any of the life stages. It is believed that as mysids were reared in constant copper and constant cadmium concentrations, various regulatory and detoxification mechanisms were employed to alleviate any potential deleterious impacts. Various cellular ligands (e.g. metallothioneins) have inter-related roles in regulating essential heavy metals and also serve to sequester non-essential heavy metals. Copper is an essential element in mysids, required in the synthesis of haemocyanin, while cadmium serves no known biological function and is deemed non-essential. With exposure to both metals, it is possible that the presence of cadmium will result in a shift in the function of metallothioneins from regulation of copper to favour detoxification of cadmium. It was hypothesised that the regulation of copper in maturing mysids would be compromised in the presence of cadmium at concentrations of copper that were previously shown to have no effect on respiration rate. In order to test this hypothesis, newly released mysids were exposed to a broad range of copper – cadmium combinations (0.002 – 0.02 mg/L of each heavy metal) and reared for a complete life cycle. Response surface methodology was used to depict the combined relationships between copper and cadmium on oxygen consumption rate. Respiration was significantly influenced by: (1) individual main effects of cadmium, copper and life stage and (2) two factor interactive effects between cadmium-copper, cadmium-stage, copper-stage and stage-stage. The responses to copper and cadmium varied among the life stages. Respiration rate was decreased in the early juvenile stages with significant influence by cadmium versus copper. However, results indicated that as the mysids matured, the influence of copper on respiration rate became more pronounced. The early adult stage was particularly sensitive to

both heavy metals while copper was more significant in influencing respiration rate in adults. These findings were not expected based on the empirical single exposure studies. It was concluded that toxicity due to copper exposure was enhanced in the presence of cadmium, which may be indicative of a shift in the role of cellular ligands in adequately regulating this essential metal. Investigations into the combined effects of copper and cadmium exposure on onset of sexual maturity, expressed as a K-Factor (ratio of mysids achieving sexual maturity to total number of mysids) were also done. Onset of sexual maturity occurs during the early adult stage as well and was delayed by both cadmium and copper exposure.

Keywords: Mysid; *Metamysidopsis insularis*; Heavy Metal; Life Stage; Mortality; Physiology; Growth; Response Surface; Sexual Maturity.