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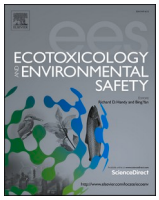

Sensitivity of freshwater organisms to cadmium and copper at tropical temperature exposures: Derivation of tropical freshwater ecotoxicity thresholds using species sensitivity distribution analysis

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ABSTRACT

Tropical freshwater ecosystems are increasingly influenced by chemical stressors including heavy metals posing threats to biodiversity. Adequate ecotoxicity data are not available for native tropical freshwater species for deriving water quality guidelines and for conducting ecological risk assessments. Objectives of this study were (i) to generate freshwater ecotoxicity data for cadmium (Cd) and copper (Cu) for tropical temperature exposures using standard laboratory bioassays with selected freshwater species and (ii) to derive ecotoxicity thresholds (protection concentrations, PC) for tropical freshwater life based on 'tropical temperature-specific exposure' ecotoxicity data. Estimated final chronic toxicity values of the six species tested in the study indicate that the most sensitive species was the crustacean, *Moina macrocopa* for both metals while the algae *Chlorella vulgaris* and the plant *Lemna perpusilla* showed highest tolerance to Cd and Cu respectively. Tropical temperature-specific exposure (25–30 °C) was used as the decision criterion for deriving ecotoxicity thresholds of Cd and Cu for protection of tropical freshwater life based on species sensitivity distribution analysis of the final chronic toxicity data sets which included published toxicity data of selected species in addition to the six species tested in this study. The derived PC99, PC95, PC90 and PC80 values for protection of tropical freshwater life under chronic exposure are 0.5, 1.2, 1.9 and 3.5 μg/L for Cd and 0.34, 0.84, 1.4 and 2.6 μg/L for Cu respectively. These derived threshold chronic values (PC99 and PC95) indicate that the established freshwater quality guidelines based on temperate species for Cu may not provide sufficient protection of the freshwater species in the tropics while the available freshwater guidelines for Cd would provide adequate protection for the tropical freshwater species. The tropical freshwater ecotoxicity thresholds derived in this study may be used with some caution as reference points for site specific ecological risk assessments in the tropics.

1. Introduction

Freshwater ecosystems in the tropical latitudes are increasingly influenced by multiple stressors that can lead to an overall reduction in biodiversity (Gatti, 2016; Sundar et al., 2020). One of the leading threats for the loss of biodiversity in the tropical ecosystems is chemical pollution stress. Hence, a sound framework needs to be established for assessing the ecological risks associated with toxic chemicals in order to protect the important freshwater biodiversity in the tropics (Wang et al., 2019a). Species sensitivity distribution (SSD) analyses can be used to compare the sensitivities of different taxonomic groups to environmental contaminants, derive threshold concentrations that protect the species diversity and formulate water quality guidelines for individual chemicals (ANZG, 2018; Signore et al., 2016). Based on SSD analysis, combined toxicity data from a set of single species tests for a particular contaminant are extrapolated to a toxicity threshold considered hazardous (e.g. HC5 for hazardous to 5% of the species) to ecosystem structure and functioning (Signore et al., 2016). In ecological risk assessments, this derived hazardous concentration can also be expressed as the concentration that is theoretically protective of a given percentage of species (e.g. PC95 for protection of 95% species) (Warne et al., 2018). However good quality tropical ecotoxicity data of native

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