Abstract

Evaluation of *Enhalus acoroides* as a potential biomonitor of heavy metal variations near mining areas

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Biomonitors are often used to assess the heavy metal contamination in an area for they have been successful in exhibiting spatial and temporal variations in the bioavailabilities of heavy metals in the environment. They offer time-integrated measurements that reflect portions of the total ambient metal load that are of direct ecotoxicological relevance. The use of seagrasses as biomonitors of heavy metals has been investigated in several studies but was only limited to species such as *Posidonia oceanica* and *Zostera marina*.

In this study, the potential of the tropical seagrass, *Enhalus acoroides* as a biomonitor of heavy metals is explored. Spatial and temporal variations of heavy metals (Cr, Mn, Co, Ni, Cu, Pb, As, Zn, Cd) in *Enhalus acoroides* in Hinadkaban Bay, Claver, Surigao del Norte were investigated to assess the species potential as a biomonitor. The variation of metal concentration between *E. acoroides* leaf and rhizome tissues were examined. Historical contamination trend of the area was traced through variations of heavy metal concentrations in the rhizomes of *Enhalus acoroides* using lepidochronology technique. *Enhalus acoroides*, water, and sediment samples were collected at different strategic sampling points representing an exposure gradient from the mine tailings. Several pollution indices were also calculated to assess the degree of contamination in the area. All heavy metal concentrations of *E. acoroides* (leaves and rhizomes), water, and sediment samples were quantified using Agilent 7500cx Inductively Coupled Plasma Mass Spectroscopy.

Analysis of variance (ANOVA) results showed significant variations ($p < 0.05$) in the metal concentrations in the tissues of *E. acoroides* (Mn, Co, As, Cd for leaf tissues while Cr, Mn, Ni, Co, Zn for rhizome tissues) and the marine sediments (Cr, Mn, Co, Ni, As, Pb) across sites, with the highest concentrations usually found at sites with closest distance from the metal sources. Post-hoc tests determined that significant differences in the metal concentrations were between the most probable contaminated sites and the least contaminated sites. Meanwhile, no significant differences in the metal concentrations in water were observed. Through Pearson correlation, concentrations of Cr, Co, and As in the tissues of *E. acoroides* were found to be significantly and highly correlated to the ambient environment metal concentrations. Variation in the metal

bioaccumulation in the tissues of *E.acoroides* was compared using paired T-test and result showed that the mean metal concentrations of Co, Ni, Mn, and Cr were significantly higher in leaf tissues than in rhizome tissues indicating the higher ability of leaf tissues to bioaccumulate these heavy metals. Through lepidochronology technique, rhizomes were retroactively dated from age 1-7 (year 2009-20015). Heavy metal concentrations across this period were found to exhibit significant exponential trends for all metals except for Pb, As, and Cu. It is also noticeable that metal concentrations increase in a constant exponential rate (which varies per metal) as rhizomes aged. This could indicate the possible ability of the rhizomes to accumulate metal through an extended period or to translocate metal across its rhizome sections. This trend, however, is found to be more prominent in sites with greater proximity to metal sources. It is also observed that rhizomes from the site nearest to the mine tailings showed higher metal concentration peaks for 2009-2011. These peaks coincided with the construction period (2009-2010) and the starting operation (2010) of an additional mining company in the area. Furthermore, it is found to be correlated with the amount of Ni production in the mining operations. Several peaks were also found to coincide with years of high precipitation. Construction period, increased mining activities, and high precipitation may have resulted in increased sediment transport in the study area and was possibly reflected in the rhizome sections of *E.acoroides*. Sediment pollution indices were found to be higher in sites that are closer to metal sources. Furthermore, all calculated pollution load index (PLI) values were indicative of heavy metal contamination in the area. The overall result of this study supported that seagrass species *E. acoroides* is a good biomonitor of heavy metals.