

Application of Biomarkers and Bioindicators for Marine Environmental Monitoring

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Pollution monitoring and environmental management primarily aim to protect ecosystem and public health. It has long been recognized chemical measurement of contaminants alone cannot provide good predictions as to the harmful biological effects or allow for direct extrapolations to be made in regards to the "health" of the environment. In the past two decades, there has been a global trend to supplement chemical and physical measurements with biological endpoints/measurements for different management purposes: (1) to identify exposure to certain chemicals; (2) to monitor spatial and temporal changes in environmental concentrations of contaminants; (3) to provide early warning of deterioration of environmental quality; and (4) to indicate occurrence of adverse ecological consequences. Change of these biological responses can be quantified and used for environment impact assessment (EIA). In spite of this, water quality standards/guidelines currently adopted by most Asian countries are still exclusively based on physical and chemical measurements.

Biological monitoring examines biological responses at different levels of organization to indicate environmental changes. Biological responses below organisimal level (i.e. molecular/biochemical/histological/behavioural responses in relation to environmental/pollution stresses) are called biomarkers. Biological responses at organismal level and above (i.e. population/community/ecosystem responses in relation to environmental/pollution stresses) are generally referred to as bioindicators. As such biomarkers that can provide a link between molecular, biochemical, histopathological, physiological, behavioral responses and Darwinian fitness traits (e.g. survival, growth and reproduction) would be particular cost effective in practical monitoring.

Since various biological responses provide unique information about the environment, it is generally accepted that a suite of biological responses covering different biological organization levels, rather than a single biomarker/bioindicator, is required to provide information on different types of environmental changes in pollution monitoring and management. This paper provides a

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Congress



23-27 November • Manila, Philippines

critical review on the pros and cons of using different biomarkers/bioindicators in environmental management. And, developed biomarkers/bioindicators that can be readily used in practical monitoring will be highlighted as examples. Countries in the Asian region should accord high national priorities to adopt and validate some of these biomarkers/bioindicators for use in their monitoring programs, so as to improve their cost-effectiveness and relevance to environmental management.