Protection of the marine environment from man-made chemicals

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Some hazardous chemicals have caused serious problems to many forms of life that range from aquatic biota to humans. Chemicals used in human activities, however, need to pose no threat to both the environment and humans. The environmental risk of chemicals (i.e. pesticides or biocides) for use in environments should therefore be clarified prior to any commercial use.

Biofouling on ship hulls can lead to increased fuel consumption, greenhouse gas emissions, and ecosystem deterioration via the transfer of invasive aquatic species. Antifouling paint is one available countermeasure used to prevent biofouling on, for example, ship hulls, fishing nets, and water cooling pipes. Organotin compounds, tributyltins (TBTs), were in use worldwide as an effective antifouling agent for about four decades until being banned for use on ship hulls by the International Convention on the Control of Harmful Anti-fouling Systems on Ships in 2008. Some alternatives to TBTs have been in use since the early 1990s, although available data on their environmental risk is still limited.

LABMEM is devoted to the ecotoxicological evaluation of alternative antifouling compounds such as Irgarol 1051, diuron, triphenylborane pyridine (TPBP), copper pyrithione (CuPT), and zinc pyrithione (ZnPT). The risk to the environment posed by a chemical can be evaluated by comparing environmental residue concentrations with their no-effect concentration on biota. Both exposure and ecotoxicity data are necessary in assessing the environmental risk of a compound. Environmental residue concentrations of Irgarol 1051 and its degradation product M1, along with their ecotoxicological concentrations, are shown in the figure; the findings suggest that Irgarol is present at concentrations that would have a significant effect on the primary producers in aquatic environments. Usage of Irgarol 1051 has already been regulated by some industrialized countries, but not in Japan. LABMEM has also recorded environmental residue of diuron, as well as Irgarol 1051, in Japanese coastal seawater. The use of TPBP has been increasing in some Asian countries, but no residue has been found to date in Japan. Neither CuPT nor ZnPT has been detected in the natural environment. We are interested on the aquatic fate of these compounds, even though they are not as persistent as TBTs. The ecotoxicity of several alternatives has been evaluated using a battery of bioassays and marine and freshwater bacteria, algae, crustaceans, fish, fish cells, macrophytes, and plant seeds. The toxic mechanism of the agents and their possible degradation products are another area of concern.

Marine sediment at trading ports and shipping yards are a sink for many pollutants from both maritime and terrestrial activities, and a secondary source of pollution. The combination of simple bioassays and chemical analysis can be a powerful tool for use in evaluating the on-site pollution caused by marine sediment. Our goal involves the management of polluted marine environments via meaningful biomonitoring.

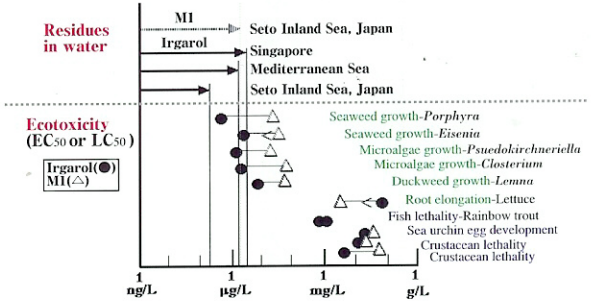

Fig. 1 Environmental risk of an antifouling agent Irgarol 1051.