Fate and toxicity of the new antifouling compound in marine ecosystem

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Summary

Irgarol 1051, 2-methylthio-4-*tert*-butylamino-6-cyclopropylamino-*s*-triazine, is a newly developed herbicidal additive for use in copper-based antifouling paints. It is intended as replacement for the highly toxic antifouling agent tributyltin, which has been regulated internationally. With the recent decline in ambient concentrations of organotins, Irgarol 1051 has emerged as a new aquatic contaminat in Europe. Currently, there is no information in the open literature on its environmental occurrence outside Europe. A three-year survey was conducted in 1996-1998 to investigate the occurrence of Irgarol 1051 in Japanese aquatic environments. A total of 2 trade ports (Mizushima and Kobe), 73 marinas and 13 fishery harbours were surveyed during 1996-1997. Irgarol 1051 was positively identified in the enclosed coastal waters of the Seto Inland Sea in Japan, ranging in concentration between 13 and 264 ng/L. Irgarol 1051 was found more frequently in fishery harbours than in marinas, indicating that besides marinas and trade ports, fishery harbours can also be a significant source of contamination for the aquatic environment. It was found that Irgarol 1051 was degraded via three different pathways such as biodegradation with white rot fungi, mercuric chloride-catalyzed hydrolysis, and sunlight degradation. Among them, photodegradation is likely to be occurred in nature. It is noteworthy that the degradation product M1 identified as 2-methylthio-4-*tert*-butylamino-6-amino-*s*-triazine was formed as one of major products in each degradation pathway. Ecotoxicity testing revealed that Irgarol 1051 and M1 were moderately toxic to a marine bacterium and the four crustaceans tested, but were highly toxic to algae. In the root elongation inhibition bioassay, M1 showed a phytotoxicity at least 10 times greater than that of Irgarol 1051 and six other triazine herbicides. These results strongly suggest that both Irgarol 1051 and its degradation product M1 may potentially affect and/or damage the primary producer community in aquatic ecosystems.