

## Antifouling Herbicides in the Coastal Waters of Western Japan

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Organtin antifouling compounds have been regulated internationally since the late 1980s and early 1990s. Alternative biocides are intended as replacements for organotins, although limited information about them is available in open literature. We have reported on the environmental occurrence (surveys No. 1–5), mode of degradation, and ecotoxicities of the new antifouling compound Irgarol 1051 since 1996. In the present study (survey No. 6), residue analyses of some antifouling herbicides (Diuron, Irgarol 1051 and its degradation product M1) were conducted in waters collected along the coast of Western Japan. In total, 142 water samples were collected from fishery harbours (99 sites), marinas (27 sites), and small ports (16 sites) around the Seto Inland Sea, the Kii Peninsula, and Lake Biwa in August 1999. A urea-based herbicide, Diuron, was positively identified for the first time in the Japanese aquatic environments, although it had been used for weed control in ploughed fields for a long time. Diuron was detected in 121 samples (86%), and the average concentration was 0.337  $\mu\text{g/L}$  with a highest concentration of 3.05  $\mu\text{g/L}$ . Diuron was detected in 86% of samples from fishery harbours, 89% of samples from marinas, and 75% of samples from ports. Four freshwater samples out of 11 collected at Lake Biwa contained Diuron, at an average concentration of 0.089  $\mu\text{g/L}$  with a highest concentration of 0.199  $\mu\text{g/L}$ . Neither Irgarol 1051 nor M1 were found in the lake waters, but both were found in many coastal waters. Irgarol 1051 was found in 84 samples (60%), with an average concentration of 0.043  $\mu\text{g/L}$  and a highest concentration of 0.262  $\mu\text{g/L}$ . The concentrations detected were of similar magnitude as found in our previous surveys, taken in 1997 and 1998. M1 was found in 40 samples (28%), with an average concentration of 0.029  $\mu\text{g/L}$  and a highest concentration of 0.080  $\mu\text{g/L}$ . The concentrations detected were lower than those found in our previous surveys No. 4 and No. 5, taken in 1997 and 1998. The detection frequency among fishery harbours, marinas, and ports was 57–70% for Irgarol 1051 and 25–30% for M1. Ninety-five per cent of the coastal waters in which M1 was detected also contained Irgarol 1051, and 93% of the samples in which Irgarol 1051 was detected also contained Diuron. These results clearly suggest that commercial ship-bottom paints including both Diuron and Irgarol 1051 are used extensively in the survey area. The residues of these antifouling herbicides in the coastal waters may have damaged a primary producer community.