Use and environmental impact of antifouling paints in the Baltic Sea

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Abstract

Biocide-based antifouling (AF) paints are the most common method for preventing biofouling, i.e. the growth of algae, barnacles and other organisms on boat hulls. AF paints for leisure boats are predominantly based on copper (Cu) as the main biocide, with zinc (Zn) present as a pigment and stabilizer. Both metals are released from the paint matrix into the water column, leading to contamination of marinas which typically have only limited water exchange. Thus, the aim of this PhD thesis was to describe the use of AF paints in different regions in Sweden, as well as the associated environmental consequences with regard to contamination of the environment and toxicity to non-target aquatic snails. Using a recently developed X-ray fluorescence application, high levels of Cu were detected on boats moored in freshwaters, despite a more than 20-year-old ban, as well as high levels of tin (Sn) on 10 % of the boats, indicating the presence of (old) tributyltin paints (TBT), which might pose an environmental risk and a health hazard for people performing the paint scraping (paper 1). In addition, very high levels of Cu and Zn were measured in the biofouling material collected from the boat hulls, and this is problematic because the biofouling is commonly disposed of on the soil in boatyards at the end of each season. No difference was found in the amount of biofouling on boats coated with Cu or biocide-free paints, which implies that Cu might be currently overused in areas of low salinity and low barnacle density (paper 2). This work also introduces the use of a new species for ecotoxicological field experiments, the snail *Theodoxus fluviatilis.* Chronic field experiments (paper 3) revealed 6-fold increases in snail mortality, negative growth and up to 67-fold decreased reproduction in marinas, compared to areas not impacted by boating (‘reference areas’). Moreover, a higher prevalence of snails with histopathological alterations (e.g. necrosis of gills, gonads, midgut gland and parasite infestation, among others) was observed in the marinas, compared to the reference areas (paper 4). Statistical modelling indicated that the majority of the toxic effects were best predicted by the metals, most likely originating from AF paints. The results presented in this thesis depict some important aspects of AF paint use in brackish water and highlight the necessity of implementing a suitable management practice for the heavily contaminated biofouling waste in order to minimize the risk to soils. In addition, the evidence of toxicity to snails in marinas can be used as a basis to increase the public understanding of the impact of recreational boating and encourage people to choose less toxic alternatives to AF paints.

Keywords: *boats, antifouling paints, metals, XRF, in situ, caging, Theodoxus fluviatilis, toxicity.*

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