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Hazard assessment of ciprofloxacin, sulfamethoxazole and triclosan for marine periphyton

Ecotoxicology, Pollution Induced Community Tolerance and Co-Tolerance

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Abstract

Antibiotics and personal care products are used in large quantities and commonly detected in various environmental compartments. The two antibiotics, ciprofloxacin and sulfamethoxazole, and the personal care product triclosan are among the most commonly detected compounds in sewage treatment plants and aquatic environments. Due to their usage patterns there is a risk that they also will end up in the coastal marine environment, where they risk affecting marine microorganisms. Despite this, only a limited number of studies have been published on their occurrence and ecotoxicity in the marine environment.

As ciprofloxacin, sulfamethoxazole and triclosan are used for their inherent antimicrobial properties, microorganisms are thus likely to be among the most sensitive organisms and the aim of this thesis is thus to perform an in depth ecotoxicological hazard assessment on natural marine microbial communities. Periphyton (biofilm forming communities composed of both autotrophic and heterotrophic organisms) from the Gullmar fjord on the Swedish west coast was used for the hazard assessments.

Chronic effects on the periphyton were assessed using two types of test systems, the semi-static SWIFT periphyton test and a flow through microcosm system. Clear concentration-dependent effects on bacterial respiration rates were observed on the periphytic bacteria after exposure to the two antibiotics, ciprofloxacin and sulfamethoxazole. Triclosan never inhibited the bacterial part of the periphyton communities despite its use as an antimicrobial agent.

Algae were on the other hand insensitive to the two antibiotics and no inhibition was observed for periphytic algae exposed to ciprofloxacin or sulfamethoxazole. Sulfamethoxazole did instead stimulate total pigment content already at the lowest test concentrations of 5 nmol/L. Triclosan did in contrast affect periphytic algae in a concentration-dependent fashion in all experiments. The triclosan experiments performed with the SWIFT periphyton test system consistently resulted in inhibition of algal pigment content while a significant increase of total and individual pigment content was seen in the flow-through microcosm experiment with triclosan. This increase was probably due to a shift in species composition, a so called toxicant induced succession, producing a community composed of species with higher triclosan tolerance.

A significantly increased community tolerance (PICT) was indeed observed for communities pre-exposed to triclosan concentrations of 100 nmol/L in the microcosm system. PICT was measured and quantified using acute inhibition of photosynthesis as well as chronic inhibition of algal pigment content (in the SWIFT periphyton test). A tenfold increase in tolerance, compared to the unexposed control communities, was observed with both methods. The chronic SWIFT test, however, detected PICT at lower exposure levels than the acute test of photosynthesis inhibition. The results for the SWIFT test thus indicate that chronic methods can be used to assess PICT.

Keywords: Antibiotics, antimicrobial agents, ciprofloxacin, sulfamethoxazole, triclosan, community ecotoxicity, periphyton, Toxicant-induced succession, Pollution-Induced Community Tolerance (PICT)