GÖTEBORGS UNIVERSITET

Effects of contaminant mixtures on marine zooplankton diversity and function

Christina Jönander
Institutionen för biologi och miljövetenskap
Naturvetenskapliga fakulteten

Akademisk avhandling för filosofie doktorsexamen i naturvetenskap med inriktning miljövetenskap, som med tillstånd från Naturvetenskapliga fakulteten kommer att offentligt försvaras fredagen den 2 juni 2023 kl. 10.00 i Hörsalen, Botanhuset, Institutionen för biologi och miljövetenskap, Carl Skottsbergs gata 22b.

ISBN (Print) 978-91-8069-281-6
ISBN (Pdf) 978-91-8069-282-3
Tillgänglig via: http://hdl.handle.net/2077/75977

GÖTEBORGS UNIVERSITET

Abstract

Chemicals have important roles in our society and can be used as ingredients in personal care products, pesticides, pharmaceuticals, as well as be components of fuels used in cars or ships. More than 350 000 chemicals and mixtures have been registered for use, which only covers a part of all the chemicals that we may come into contact with. The frequent use of chemicals can result in both intentional and unintentional release of many substances to the environment, where many eventually end up in the sea. These contaminant mixtures have the potential to adversely affect marine organisms, particularly as mixtures of chemicals are known to cause larger effects than when applied individually. Some of the organisms that first encounter contaminants in the water are zooplankton. This diverse community consists of organisms that span many phyla, and that have many important functions in the pelagic food web. Some of these include grazing on microalgae that can cause harmful blooms, and constituting an important food source for larger organisms such as fish.

In this thesis, I aim to investigate the impacts of both unintentional mixtures (generated from a single source) and coincidental mixtures (originating from several sources) on the biodiversity and function of two trophic levels of marine zooplankton, and to find out which chemicals in the respective mixtures that are the main contributors to their toxicities.

The first two papers focus on the effects from unintentional mixtures originating from shipping activities, and the second two focus on effects from coincidental mixtures found in marine surface water near urban areas with industry. All studies involve effects of contaminant mixtures on natural marine zooplankton communities used in laboratory experiments.

The results in this thesis show evidence of clear mixture toxicity of all tested mixtures, in line with what has been observed elsewhere. The findings include effects on both alpha and beta diversity in zooplankton, and on mesozooplankton ability to feed and reproduce, at concentrations of contaminants that already exist or are likely to exist in the marine environment. The findings demonstrate that the estimated toxicity is generally lower using a component-based approach, where toxicity is modelled using the individual toxicities of the substances, than when using a whole mixture approach, where zooplankton are exposed to an entire mixture. The results demonstrate that there are generally few substances in each mixture that are driving the toxicity, although the number of these toxicity-drivers vary between different mixtures.

The findings of this thesis contribute to a broader perspective of how contaminant mixtures affect marine zooplankton in their environment, by including endpoints such as species diversity, and ability to feed and reproduce, which are normally not included in chemical risk assessment. Furthermore, the findings suggest that there are cause for concern regarding the impact of chemicals present in coastal environments near industry, as well as from wastewater discharged from ships with exhaust gas cleaning systems (closed-loop scrubbers), as they have the potential to harm zooplankton in coastal waters.

Keywords: zooplankton, copepods, ciliates, dinoflagellates, mixture toxicity, chemical mixtures, marine contaminants, biodiversity, reproduction, ULSFO, closed-loop scrubbers, exhaust gas cleaning systems