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Sensitivity of Arctic zooplankton to chlorine as ballast water treatment

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Introduction

Climate change has caused the retreat of sea ice in the Arctic region, opening up the northern sea route for shipping. This route has great economically advantages, but also allows unwanted alien species to enter and pass the Arctic region. To stop the spread via ship's ballast water, a treatment to sterilize the ballast water will be used. Chemicals related to ballast water treatment may enter into the ecosystem posing new and unknown risks for this specific region.

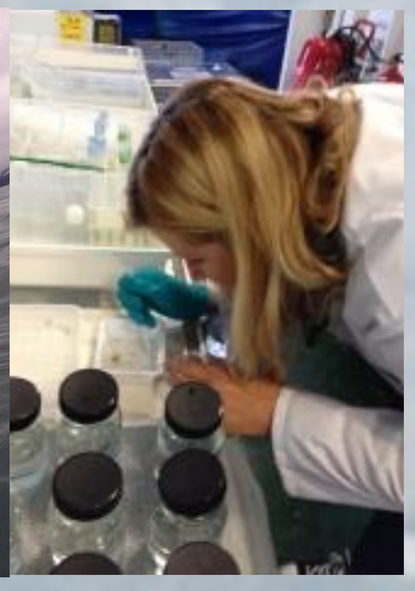
During the Dutch expedition SEES.nl to Spitsbergen in August 2015, the sensitivity of Arctic zooplankton to chlorine as ballast water treatment chemical was investigated for the first time. Locally collected zooplankton species were exposed to a range of electrochemically produced chlorine concentrations and the mortality was monitored.

Methods

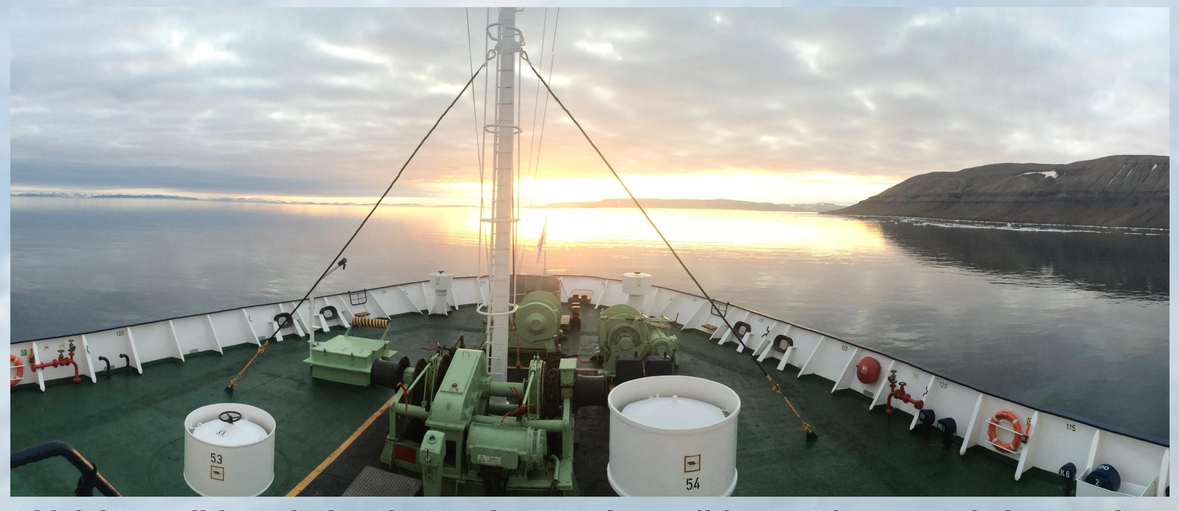
Zooplankton was collected in a Zodiac by gently dragging a 50 µm plankton net though the top layer of the Arctic water. The plankton in the cod end of the net was rinsed into a bottle using local water. Local water was collected for the tests. All samples were taken back to the mobile laboratory on board of the m/v Ortelius.

Chlorine was produced in a high concentration using a laboratory scale electrochlorination unit provided by RT SafeBallast. The concentration of Total Residual Oxidants (TRO) was determined using a DPD-colorimetric method and a concentration series was prepared: 0, 0.1, 0.3, 1, 3 and 10 mg/l as Cl2.

Based on the availability of the collected zooplankton, choices were made for species and communities on volume and number of species ratio. Species were exposed to the test concentrations and stored in a fridge, temperature was logged every 15 minutes. Every 24h the mortality of the organisms was assessed using a stereomicroscope. The species were considered dead if they did not exhibit any internal or external movement in 10 seconds of observation. The LC50, the concentration where 50% of the species in a test died was calculated.



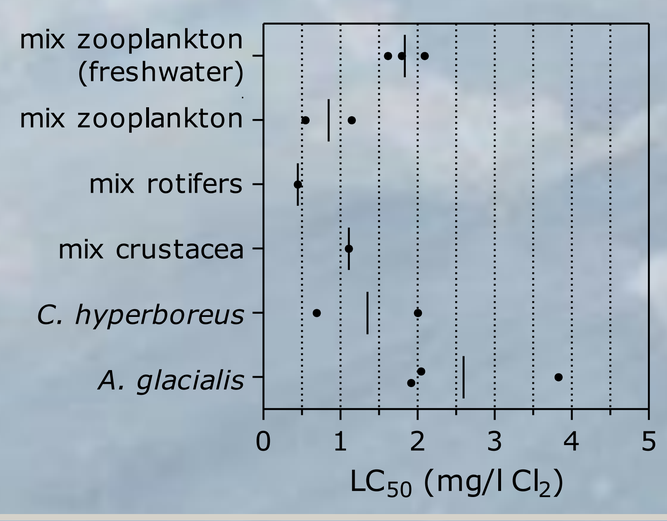
Left: Collecting zooplankton (Picture: D. Maat), Right: Selecting species for a toxicity test (Picture: M. Van den Heuvel-Greve)



Midnight conditions during the Dutch SEES.nl expedition to Edgeøya, Spitsbergen, in August 2015 (Picture: A. Sneekes)

Results

During the expedition in total 12 tests could be done. It was possible to repeat the test for two species, namely the copepod *Calanus hyperboreus* and the amphipod *Apherusa glacialis*. Other species could not be collected in sufficient numbers for a repeated test and sometimes several species were tested jointly as "community" due to the low numbers of individuals per species. Tests were executed in a temperature range of 0.4 to 6.9°C.



Toxicity after 24 hours for Arctic marine zooplankton to electrochemically produced chlorine as ballast water treatment chemical

Conclusions

- The locally collected Arctic zooplankton were suitable for use in toxicity tests and repeated tests showed similar results.
- Experience with the behaviour of the species is needed to rapidly asses stable effects.
- The smallest plankton (rotifers) were most sensitive to chlorine and the biggest species (amphipod *A. glacialis)* were least sensitive to chlorine.
- Toxicity after 24, 48, 72 and 96 hours showed similar results, although it is preferable to use 24 and 48 hours of exposure.
- The first results seem very promising and the next step is validation of the toxicity tests with Arctic zooplankton and comparison with temperate species.

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