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How does temperature affect the acute toxicity of oil at sea?



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Introduction

Although literature shows little difference in sensitivity to oil between Arctic and temperate species when tested at their optimal conditions, temperature may affect the viscosity and solubility of oil, and the physiology of species. A change in chemical characteristics due to temperature may cause a shift in a curve of a Species Sensitivity Distribution (SSD) response to oil to the right or left, whereas a change in organism response due to temperature may change the angle of the slope of an SSD-curve for oil (figure 1).

It is important to know the behaviour and toxicity of oil when oil is spilled at sea in the cold Arctic Ocean to be able to develop proper risk assessments and effective mitigation measures.

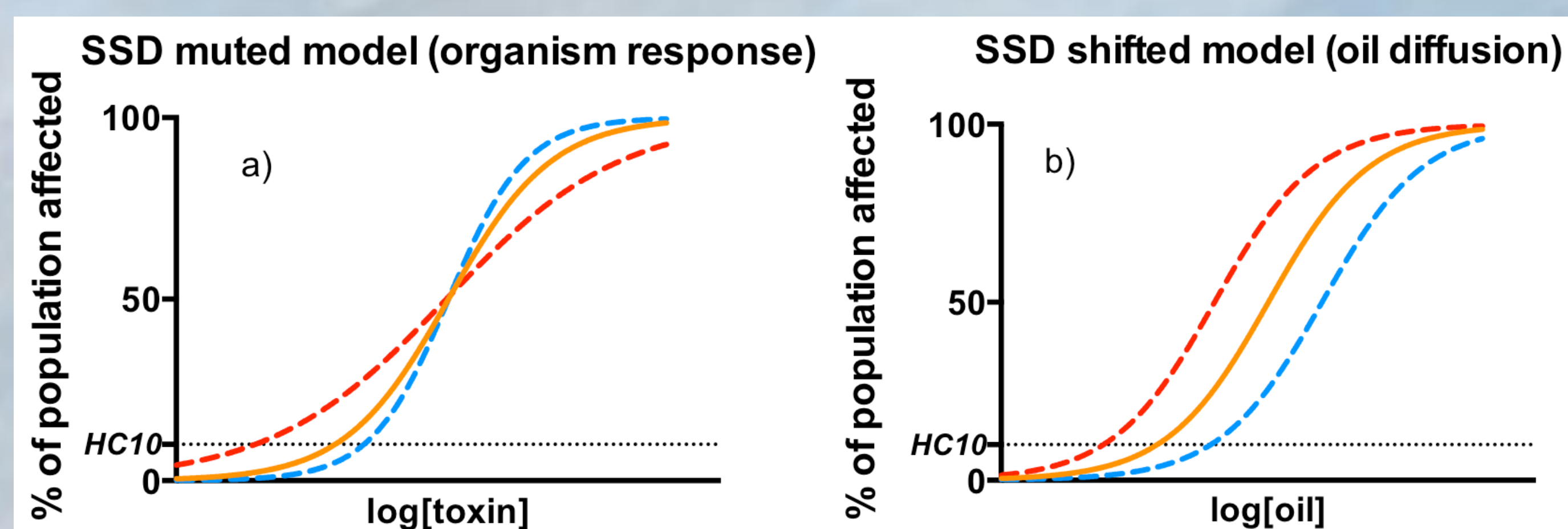


Fig.1. Hypothesized effects of temperature on SSD responses to oil : a muted biological (a) and shifted chemical (b) response.

Methods

Five temperate invertebrate species were exposed in a laboratory controlled room to a Water Accommodated Fraction (WAF) of oil (DMA) at three temperatures (4°C, 12°C and 20°C) in spring 2015. Test organisms were either lab cultured or collected from a clean site in the Oosterschelde, the Netherlands.

Temperate LogEC50 values were calculated for five species at 12-20°C and four species at 4°C. At 4°C the larval test with *Psammechinus miliaris* could not be performed. LogEC50 values were used to construct an SSD.



Left: Preparation of the WAF, **Middle:** collection of temperate field organisms, **Right:** conducting the toxicity tests (Pictures: M. Van den Heuvel-Greve)



Pack ice conditions during the Dutch SEES.nl expedition to Edgeøya, Spitsbergen, in August 2015 (Picture: M. van den Heuvel-Greve) .

Preliminary results

A shift towards the right of the 4°C-SSD-curve indicates that species are less sensitive to the pipetted test concentrations at 4°C, whereas the 12-20°C curves are not completely separated (figure 2). Chemical analysis of the WAF concentrations are planned and will provide a further insight into temperature effects on oil behaviour.

Temperature also affects species' sensitivity ranking within the SSDs. This indicates that specific groups could be affected under different climates.

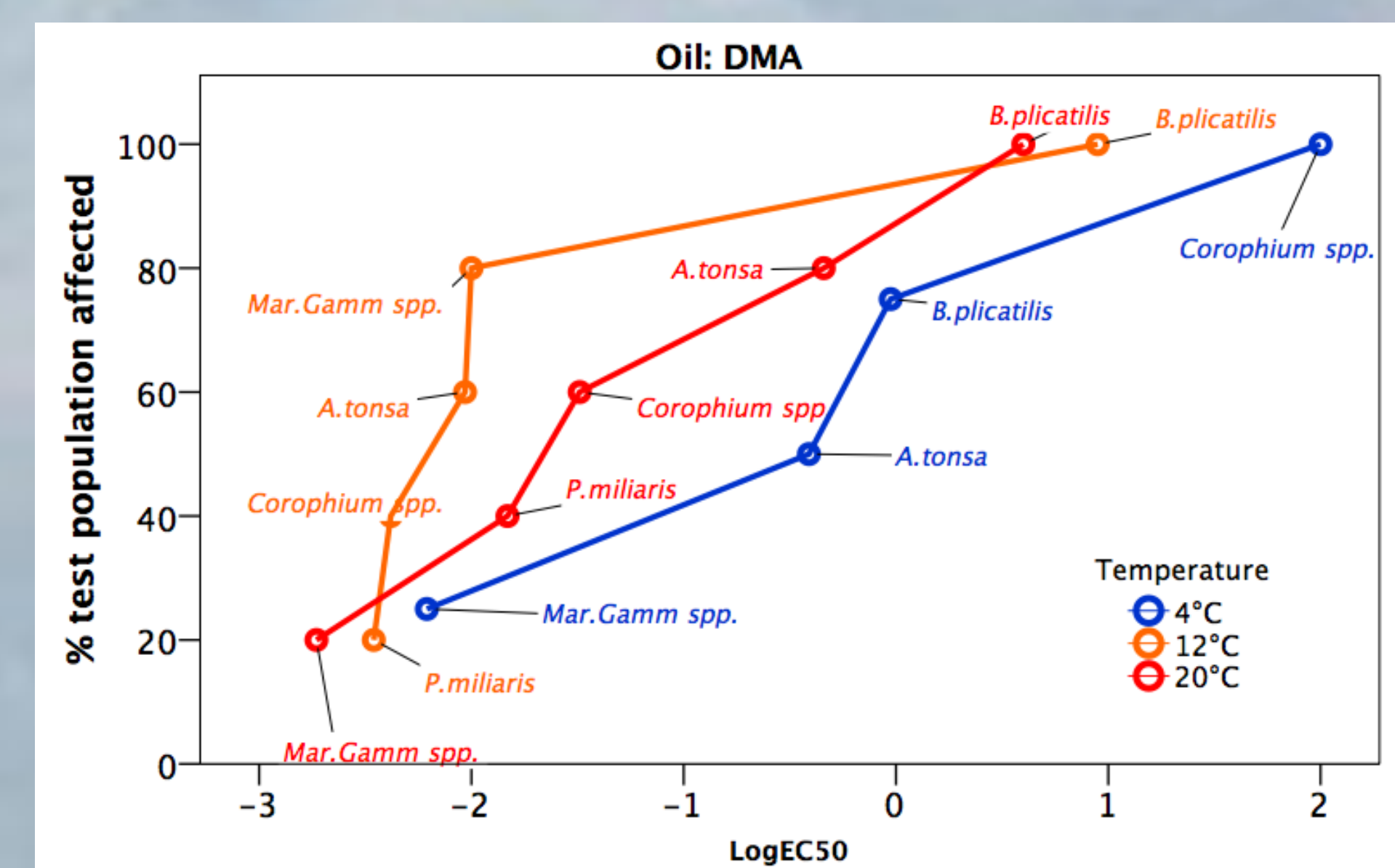


Fig. 2. SSD for a DMA WAF (nominal concentrations) and temperate species at three temperatures.

Conclusions

- Test species responded less sensitive to nominal oil concentrations at 4°C. Actual chemical concentrations are needed to assess the possibly lower exposure at lower temperatures.
- Temperature affects species' sensitivity ranking within an SSD.

Recommendations

- Compare responses of Arctic species at 4°C with temperate species at their usual temperature, at the same real exposure concentration.
- Determine the relative contribution of more hydrophilic oil components in the WAF at the different temperatures, as these usually are the most toxic ones.

Acknowledgements

The authors would like to thank the Wageningen UR System Earth Management Program (KB-24-002-018) and TripleP@Sea innovation Program (KB-14-007) for funding and Ben Bekooy for the portrait picture.



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