SCIENCE FOR ENVIRONMENT POLICY

Chlorination of ballast water may be insufficient to minimise spread of alien species

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Ballast water in ships is a principal way in which alien species are introduced into new aquatic habitats. Commercial trading ships are, therefore, required to treat their ballast water to meet discharge standards and regulation. The International Maritime Organisation (IMO) has approved a range of methods for ballast water treatment, such as filtration, ultraviolet radiation and chlorination. A recent study used DNA metabarcoding-based[1] analyses to explore the efficacy of the most widely adopted approach — chlorination — finding that it affects zooplankton organisms unequally and may potentially even increase the chances of introduced populations becoming established in new habitats.

At present, there is no EU law directly tackling ballast water. However, an IMO treaty aiming to prevent the spread of potentially harmful aquatic organisms via ballast water — the International Convention for the Control and Management of Ships' Ballast Water and Sediments — came into effect in 2017, and guidance based on IMO management standards was published by the European Maritime Safety Agency[2] in 2019. The IMO regulation requires ships to meet strict quotas by ensuring that their ballast water discharge contains less than 10 viable large organisms per cubic metre (diameter of ≥ 50 μm), and 10 viable smaller organisms per millilitre (diameter ≥ 10 and < 50 μm).

The present IMO guidelines list chlorination, filtration and ultraviolet radiation as methods for killing potentially invasive alien species present in ballast water. However, the IMO ballast management regulations are based on the total abundance of viable organisms in the ballast water (propagule pressure)[3], which does not fully address the total number of species present (colonisation pressure)[4].

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Chlorination of ballast water may be insufficient to minimise spread of alien species (continued)

In a recent study, researchers argue that measures based on propagule pressure alone may be inadequate, as research suggests that a strong reduction in propagule pressure might cause any remaining organisms to become more adaptable to new environments. This selection pressure could, therefore, lead to a greater chance that some alien species, spread by ballast water, become established than propagule pressure may predict. If lowering the propagule pressure is selective, understanding colonisation pressure due to ballast water treatment is important for risk assessment and management of alien species.

This study sought to determine if the internationally accepted practice of using chlorine to treat ballast water lowers the risk of biological invasions. The researchers used a DNA metabarcoding approach to estimate colonisation pressure and relative propagule pressure of zooplankton communities in control and chlorine-treated tanks during four transatlantic voyages. They found that neither the transportation nor the chlorine treatment significantly lowered the colonisation pressure of zooplankton species in ballast water. The chlorine treatment lowered the presence of some groups, such as Mollusca, within the zooplankton, but increased the numbers and relative propagule pressure of others, such as some Copepod species.

Overall, the analysis shows that chlorine treatment of ballast water does not affect all zooplankton species equally. Some groups are susceptible — as shown by a fall in abundance — whilst other species are not, with abundance increasing as the chlorine triggers dormant stages to hatch. The researchers recommend using DNA metabarcoding-based techniques to assess the overall biodiversity present in ballast water and suggest that a combination of different technologies could be used to reduce the risk of introduction of alien species by ballast water. They posit that there is a need to better understand the relationship between total propagule pressure and individual species' propagule pressures.

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1. Metabarcoding is barcoding of DNA or eDNA (environmental DNA) that allows for simultaneous identification of many taxa within the same (environmental) sample, but often within the same organism group.

2. See: http://www.emsa.europa.eu/implementation-tasks/environment/151-ballast-water/3472-ballast-water-management-guidance-for-best-practices-on-sampling.html

3. Propagule pressure is a combined measure of the number of individuals of a species released into a habitat to which they are not native. It includes an estimate of the total number of individuals involved in one release event (propagule size) and the number of release events (propagule number). An increase in either of these elements increases the propagule pressure.

4. Colonisation pressure is the number of non-native species introduced into a habitat and, combined with propagule pressure, is a key determinant in the number of species that successfully invade new habitats.