Rising temperatures could accelerate radiation induced DNA effects in marine mussels

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Increased sea temperatures could dramatically enhance and accelerate radiation-induced DNA effects in marine invertebrates, a new study suggests.

Led by Plymouth University, in conjunction with the Centre for Environment, Fisheries and Aquaculture Science (Cefas), the research for the first time explored the impact of rising temperatures coupled with the presence of tritium, an environmentally relevant radionuclide, on marine mussels (Mytilus galloprovincialis).

Studies carried out under laboratory conditions demonstrated that at radiation dose rates considerably below the recommended international guidelines, induced DNA strand breaks appeared earlier at higher temperature compared to lower temperature. At 15ºC, DNA damage was only significantly elevated after seven days in contrast to 25°C where a similar response was observed after three days.

Scientists involved say this suggests an acceleration of radiation-induced DNA damage and potentially compromising defence mechanisms as indicated by changes in expression profiles of genes involved in heat-shock protection, cell cycle progression and repair of DNA breaks.

Temperature is an abiotic factor of particular concern for assessing the potential impacts of radionuclides, many of them having very long half-

lives, on marine species, and with sea surface temperatures forecast to rise 0.5-3.5?C in the next 30-100 years, determining the interaction of radiological exposure has never been more important.

Awadhesh Jha, Professor of Genetic Toxicology & Ecotoxicology, led the study and said: "Ionising radiations are known to induce genetic damage, and radiation-induced genetic damage could be modified by many environmental factors, including temperature. Compared to other radionuclides, large amounts of tritium are discharged, mostly as water, in the marine environment by nuclear power plants (NPPs) and nuclear fuel reprocessing plants (NFRPs). In addition, cooling water from nuclear installations is one of the major sources of tritium in the aquatic environment. As thermal discharges from nuclear facilities is an important environmental issue, second only to the release of radionuclides which could extend for a long distance from the discharge point, such studies are important in determining the hazard and risk to the natural biota and therefore environmental sustainability."

Brett Lyons, from the Environment and Animal Heath group based in Cefas' Weymouth laboratory, co-supervised the study and said: "These results are important as they allow us to better understand the risks a warming ocean poses to marine life. We already know climate change is impacting things such as fish physiology, reproduction and migration, but this research is part of a growing body of evidence that is suggesting rises in sea water temperature may increase the risk posed by certain chemical and physical pollutants."

For the study, published in the *Journal of Environmental Radioactivity*, the mussels were exposed to tritiated water (HTO) with differing temperatures of 15°C and 25°C, and DNA damage and gene expressions were determined along with accumulation of tritium in different tissues of the mussels over a period of seven days.

In their conclusion, the authors say: "This study is the first to investigate temperature effects on radiation-induced genotoxicity in an ecologically representative marine invertebrate. It represents an important step forward in radioecology in general, and our study suggests that mussels (or similar marine species) exposed to increased temperature and HTO may have a compromised ability to defend against genotoxic insult at the molecular level. This is particularly pertinent in the context of rising sea temperatures and thermal pollution. The study suggests there is still a pressing need to investigate the interactive effects of temperature and other abiotic factors in conjunction with radiation exposure on aquatic organisms."

More information: Lorna J. Dallas et al, Exposure to tritiated water at an elevated temperature: Genotoxic and transcriptomic effects in marine mussels (M. galloprovincialis), *Journal of Environmental Radioactivity* (2016). DOI: 10.1016/j.jenvrad.2016.07.034

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