Zooplankton rapidly evolve tolerance to road salt

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Zooplankton rapidly evolve tolerance to moderate levels of road salt. Credit: Rensselaer Polytechnic Institute

A common species of zooplankton—the smallest animals in the freshwater food web—can evolve genetic tolerance to moderate levels of

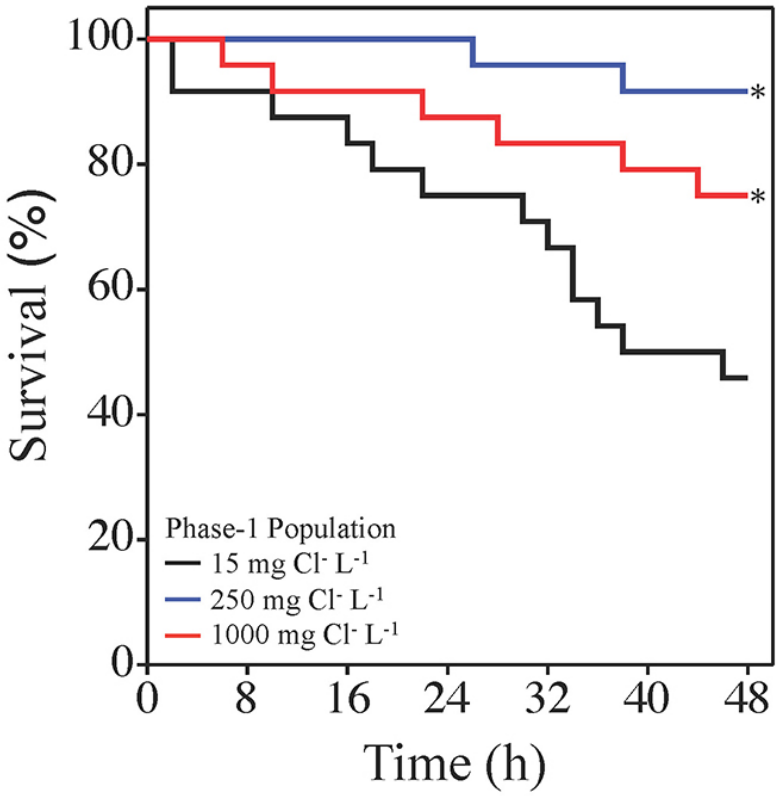
road salt in as little as two and a half months, according to new research published online today in the journal *Environmental Pollution*. The study is the first to demonstrate that the animals can rapidly evolve higher tolerance to road salt, and indicates that freshwater ecosystems may possess some resilience in the face of a 50-fold increase in road deicing salt applications since the 1940s.

"These animals evolved tolerance in just two and a half months. That's a really short time period, far faster than we often think of evolution happening," said Rick Relyea, lead researcher and a professor of biological sciences at Rensselaer Polytechnic Institute. "The hopeful message here is that, to some degree, zooplankton can evolve a higher tolerance to salt than is found in pristine wetlands and lakes and, in turn, help protect these ecosystems from the impacts of salt."

The research is part of the Jefferson Project at Lake George—a collaboration between Rensselaer, IBM Research, and The FUND for Lake George—founded to develop a new model for technologically enabled environmental monitoring and prediction to understand and protect the Lake George ecosystem and freshwater ecosystems around the world. Relyea is director of the Jefferson Project and the David M. Darrin '40 Senior Endowed Chair at Rensselaer.

The use of deicing road salts has increased from .28 million metric tons per year in the 1940s to over 16 million metric tons per year today. As part of the Jefferson Project, the Relyea lab is conducting a suite of experiments to test the effects of road salt on ecosystems. Recent research was reported in an article in the *Canadian Journal of Fisheries and Aquatic Sciences*, which found that high levels of road salt can alter the sex ratios of frogs; an article in *Environmental Toxicology and Chemistry*, which documented the effects of road salt and a common insecticide on wetland food webs; and an article in Environmental Pollution, which examined potential interactions between road salt,

predators, and competitors in wetland food webs.



Zooplankton descended from populations previously exposed to road salt for 5-10 generations (2.5 months) were more likely to survive concentrations as high as 1,300 mg chloride per liter. Credit: Rensselaer Polytechnic Institute

In the newly published work, researchers tested whether a common species of zooplankton, Daphnia pulex, could evolve increased tolerance to road salt. Daphnia pulex is vital to freshwater ecosystems. It is a major consumer of algae and a preferred food source for many fish species. Water quality suffers in ecosystems where Daphnia populations have declined, and the loss of Daphnia can have cascading effects through the food web. For example, a lack of healthy zooplankton

populations can trigger harmful algal blooms.

Using 1,200-liter tanks outfitted to mimic lake ecosystems, researchers exposed Daphnia to five levels of road salt (sodium chloride) ranging from a relatively low concentration of 15 milligrams chloride per liter (the current Lake George concentration) to a high concentration of 1,000 milligrams per liter (mimicking highly contaminated lakes in North America). After two and a half months, about five to 10 generations in Daphnia, the researchers collected the Daphnia from each tank and raised their progeny for three generations under low salt concentrations.

Researchers then studied how well the descendants of the different populations fared when subsequently exposed to road salt, from 30 to 1,900 milligrams per liter, for 48 hours. At the intermediate salt concentrations, populations previously exposed to elevated concentrations of salt had higher rates of survival than populations previously exposed to natural concentrations of salt. For example, when exposed to 1,300 milligrams per liter, descendants of Daphnia previously exposed to 250 milligrams per liter experienced 92 percent survival whereas descendants of Daphnia previously exposed to 15 milligrams per liter experienced only 46 percent survival.

"At the highest concentrations of salt, none of the zooplankton survived. But under moderate concentrations, much higher than those found in Lake George, these zooplankton evolved higher tolerance," said Relyea. "This is the first study to demonstrate that zooplankton can evolve increased tolerance to road salt, and the results were quite unexpected."

In follow-up research, the Relyea lab is testing whether Daphnia with evolved tolerance to road salt protect the food web against future road salt contamination. The team is also examining how evolved tolerance affects other aspects of Daphnia, such as their growth, reproduction, or life span.

More information: Kayla D. Coldsnow et al, Rapid evolution of tolerance to road salt in zooplankton, *Environmental Pollution* (2017). DOI: 10.1016/j.envpol.2016.12.024

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