# Warming oceans and rivers cause genomic changes in fish, scientists find

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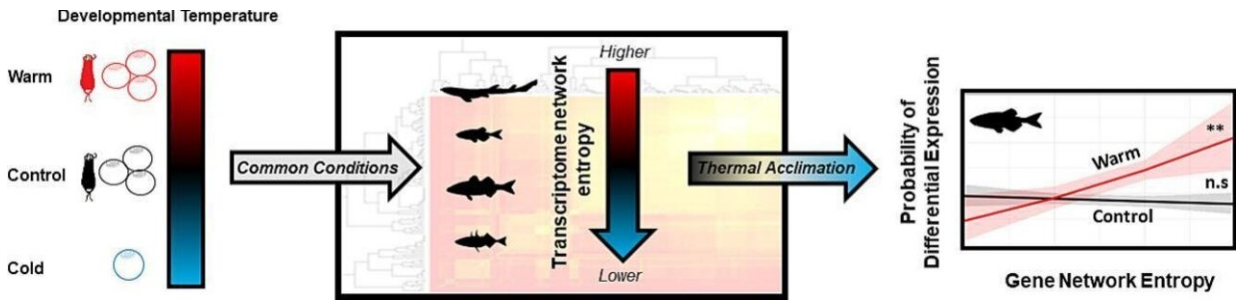


Graphical abstract. Credit: *Science of The Total Environment* (2023). DOI: 10.1016/j.scitotenv.2023.165954

A study of four common fish species by University of Manchester scientists has revealed that gene expression changes when their developing embryos are exposed to warmer waters.

The analysis of the small-spotted catshark, zebrafish, European seabass, and the three-spined stickleback is published in the journal *Science of The Total Environment*.

Though scientists already know that the warming of our rivers and oceans causes direct physiological stress to fish, this study shows the impact on their developing embryos has a deep-seated effect on their gene expression patterns as adults.

These changes may also affect their capacity to respond to future changes in temperature, having consequences for surviving climate change in their adult life.

Scientists have failed to find consistent differentially expressed genes implicated in biological changes linked to global warming.

However, the University of Manchester analysis suggests different phenotypes identified in later life may occur through changes in the organization of the transcriptome—the genetic code as it is read—one crucial element of life itself.

Their findings, using sophisticated modeling, show that transcriptomes of developmentally warmed fishes are characterized by an increased disorder in the way genes interact, implying a less structured, more 'random' set of gene interactions.

Professor Holly Shiels, from The University of Manchester, said, "Climate change is a major threat facing animals. As the world's oceans and rivers continue to warm the physiological and population level stresses exerted upon fishes will continue to grow.

"If we are to predict and mitigate the consequences of global warming, it is crucial we understand how it influences an animal's biological capacity to respond to future environmental challenges."

Dr. Dan Ripley, from The University of Manchester, said, "Our findings suggest that exposure to elevated temperatures during the development and growth of an embryo may influence the ability of fish to respond to future challenges they face in later life."

Dr. Adam Stevens, from The University of Manchester, added, "In our study, we found that developmental warming influenced the

relationships between genes. The 'plumbing' of the system was changed, with knock-on consequences for how it then functions in adulthood.

"This was absent in animals reared under 'control' conditions."

The embryos were held in either control conditions, representing everyday temperatures, or warmer treatment conditions, representing future conditions under climate change.

Following embryogenesis, all fish were moved to control conditions, simulating adult fish in the wild moving to find areas at their preferred temperature.

Despite living in their preferred temperature range as adults, genomic differences were found between the groups related to the temperatures they experienced as embryos.

These differences were associated with an altered capacity to respond to future warming as adults.

**More information:** Daniel M. Ripley et al, Warming during embryogenesis induces a lasting transcriptomic signature in fishes, *Science of The Total Environment* (2023). DOI: 10.1016/j.scitotenv.2023.165954

Provided by University of Manchester